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DC Servo Controller based on RCS4AXIS version 1.7

Document version 1.01

For Technical Support, latest version of the user manual, downloading setup files and Parts Sales, visit:

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Safety

Personal Safety - An Important Issue
Always remember, your safety is of the greatest importance. Please make sure that you are familiar with your machine and its tools, as well as the material you are working on. Failure to be knowledgeable may result in serious personal injury or damage to the machine. Common sense will be your greatest defense.

1) **Personal Clothing and Jewelry:** Clothing must be kept away from the machine. Make sure to keep sleeves away from rotating bits, gears, and belts. Frayed strips of clothing or tie straps on shop aprons are especially dangerous, so you must be aware of these at all times and should cut them short, or tuck them out of the way. Jewelry has absolutely no place in the workshop. Watches, bracelets, and necklaces may get caught in the machine or in the tool bit.
2) **Ear and Facial Protection:** Eye protection is mandatory! Safety glasses or a face shield must be used at all times. Appropriate measures must also be taken to protect the ears from loud noise. Over a period of time, permanent hearing damage may occur. Others who work near the machine should also wear ear protection while the machine is running.
3) **Working Close to the Router Bit:** Use a push stick to clear away debris near the router bit, never your hands. Make sure that under no circumstances is any part of your body or any foreign items (such as extra router bits, pens, or tools) in the tool path while the machine is running.
4) **Air Quality:** When cutting certain materials, the chips may become airborne particles and be inhaled by the operator. Many materials are carcinogenic and will be inhaled unless the operator takes the proper precautionary measures. Face masks, rebreathers, or respirators may be required, especially when working with foam materials. Check face masks, as many filter different types of materials and may not trap the particles of the material that is currently being machined. Misting systems may spray dangerous chemicals or coolants into the air; these must not be inhaled. Never use flammable or corrosive liquids in a mister or a sprayer.

Before Running the Machine

1) **Inspect the Tool Bit:** Before starting any job, a visual inspection of the machine and the tool bit should be done. Any tool that is damaged must be replaced before using the table. Pay particular attention to the use of carbide bits, as they may shatter when damaged (pay attention to long bits, over 2" exposed, used at speeds over 8k RPM. If must be used at speeds under 8k RPM, use dial indicator. Runout < 0.004). The cost of a new bit is usually less than the cost of labor and material to repeat a job.
2) **Use the Proper Tool:** Each material requires use of the proper tool bit. Incorrect selection of bit may result in damage to bit, motor, and/or material.
3) **Keep an Organized Workspace:** Before starting any job, ensure the operator's area is clear. Remove material and secure wires, hoses, and cords from operator's area. Inspect cords for proper connections and damage.

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Electrical Safety

- Grounded equipment must be plugged into an outlet, properly installed and grounded in accordance with all codes and ordinances. Never remove the grounding prong or modify the plug in anyway. Do not use any adapter plugs. Check with UL approved tester or a qualified electrician if you are in doubt as to whether the outlet is properly grounded. If the equipment should electrically malfunction or break down, grounding provides a low resistance path to carry electricity away from user.
- Don't expose electrical equipment to rain or wet conditions. Water entering electrical equipment will increase the risk of electrical shock.
- Do not abuse cord. Never use the cord to carry the equoipment or pull the plug from an outlet. Keep cord away from heat, oil, sharp edges or moving parts.
- Replace damaged cords immediately. Damaged cords increase the risk of electrical shock.
- Use proper extension cords. Insufficient conductor size will cause excessive voltage drop and loss of power.
- Use only three-wire extension cords which have three-prong grounding plugs and three-pole receptacles which accept the equipment's plug. Use of other extension cords will not ground the equipment and increase the risk of electrical shock.
- The controller should only be opened for troubleshooting by certified electrician. Both AC and DC voltages inside the controller box are dangerous. Please pay attention to warning sign for **RISK OF ELECTRIC SHOCK.**

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Quick Setup

1) Install Mach3 Software: For Mach 3 software download, minimum requirement for PC and installation and instructions visit:

   http://www.machsupport.com/

2) Install the registration key of Mach3 software if you have one.

3) Download the **Mach3Mill.xml** from:

   http://ridgecontrolsystems.com/CNC-controller/Mach3Mill.xml

   (Right click with the mouse and select "Save Link as ...")

4) Replace the default **Mach3Mill.xml** with one that you downloaded.

5) Open the controller case and verify all connectors are fully plugged and there is nothing unplugged due to shipping or shipping related inspections.

6) If there are ESTOP push buttons on the side of gantry, remove the jumper JP2, see **Board Setup** chapter.

7) Replace the controller case cover and tighten the screws.

8) Plug the table connectors for motor power, encoder, limit switch connector AUX I/O, and also power as per nameplate of controller, see **Case Connectors**.

9) Connect the controller to the PC parallel port. For Smooth Stepper(TM) the connector will be either USB or Ethernet.

10) Verify that steps per inch for all axes are correct, see **Motor Tuning** chapter.

11) Verify that spindle speed is correct, see **Spindle Speed Tuning** chapter.

12) Verify the normal operation of the machine, see **Normal Operation** chapter.

13) Verify the operation of Z-touch plate, see **Probe** Chapter.

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Board Setup, Connector Definitions and Jumpers

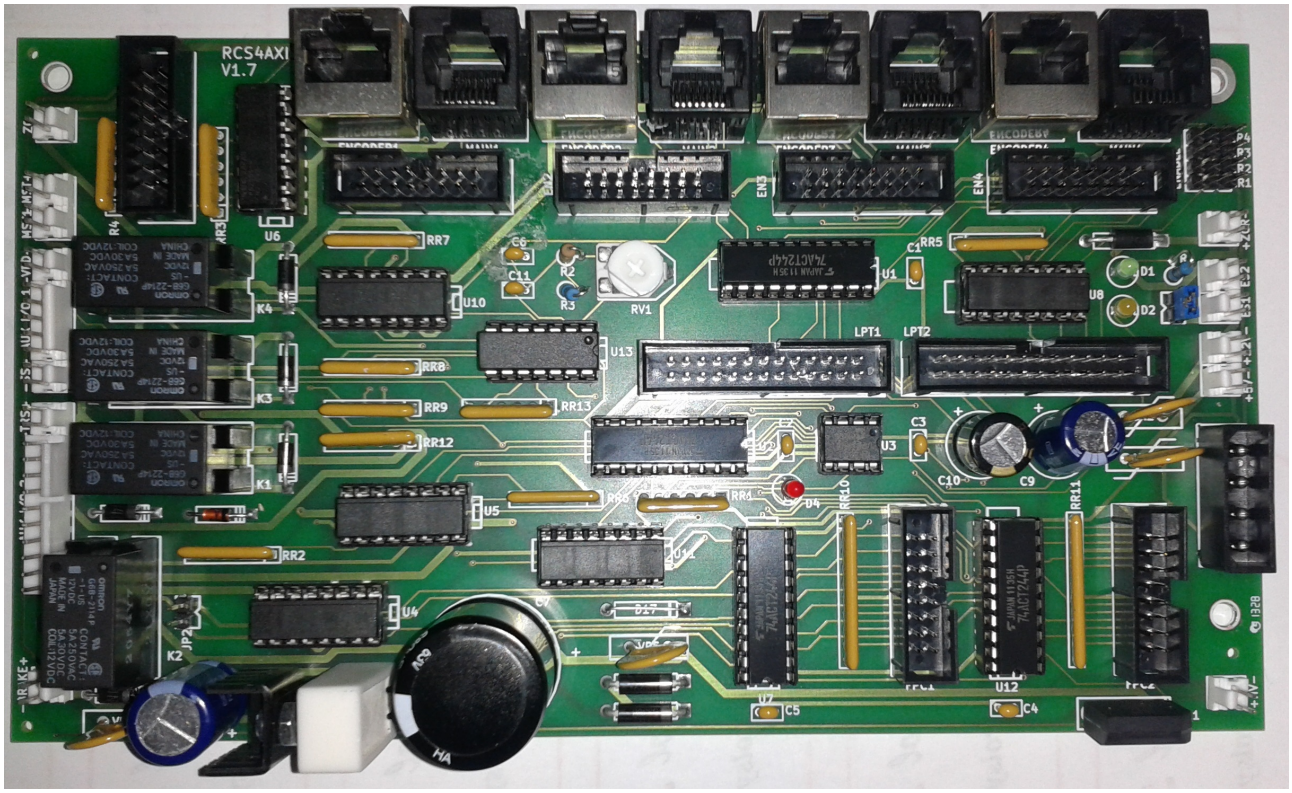

Figure 1: RCS4AXIS v1.7 has support for 4 motors, spindle, mister, Z probe, tool changer sensor inputs, tool release and limit switches.

Normal operation of the board: As soon as the board is powered up, D1 (green) and D2 (yellow) LED:s should turn on. This indicates that 5VDC and 12VDC are available for operation of the board. D4 (red) LED will turn on for three seconds and will turn off again. When all ESTOP:s are pulled out, system has been enabled from Mach3 and there are no fault on amplifiers (drives), the D4 will blink on for 1 second and off for 1 second.

D1(green) is ON	12VDC supply is available.
D2(yellow) is ON	5VDC supply is available
D4(red) is blinking	No ESTOPS. No drive fault. System enabled from software.

The location of the LED:s are marked on Figure 2.

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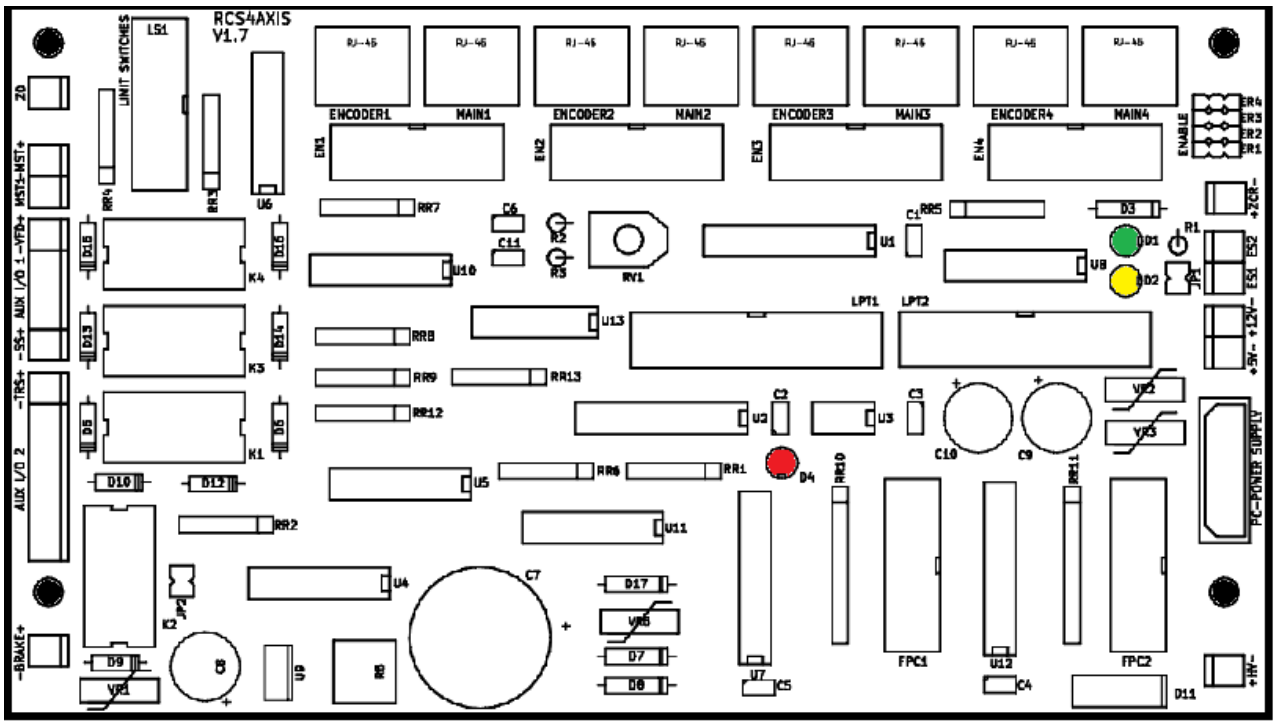

Figure 2: RCS4AXIS v1.7 Breakout board. There are three LED:s on the board.

RCS4AXIS is designed for easy replacement and maintenance. The connectors are box headers, Molex and RJ45.

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Drive Connectors on the Top of the Board

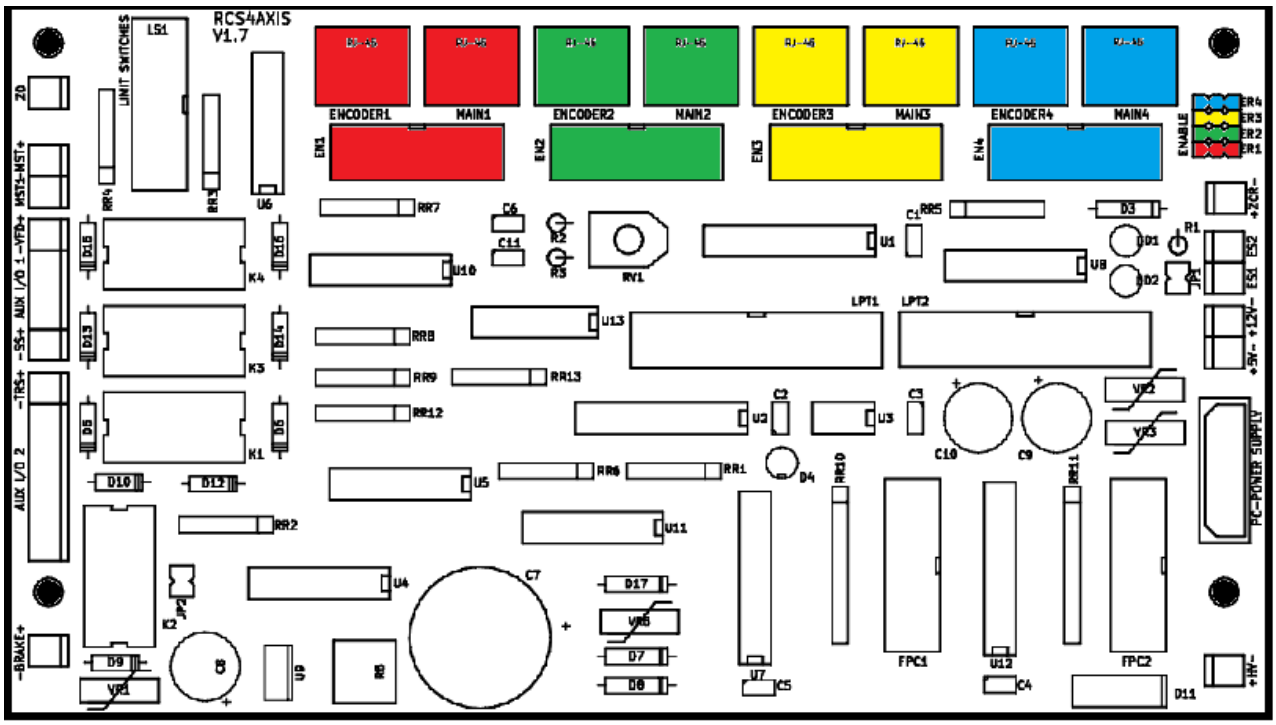

Figure 3: The board supports 4 axes. Each group of connectors with same color are going to control one axis.

ENCODER1, MAIN1, EN1 and ER1 control the X-axis.

ENCODER2, MAIN2, EN2 and ER2 control the Y-axis.

ENCODER3, MAIN3, EN3 and ER3 control the Z-axis.

ENCODER4, MAIN4, EN4, and ER4 control the X2/A-axis.

ENCODER1: Encoder for X-axis (RJ45)

MAIN1: Main for X-axis (RJ45)

EN1: Encoder for X-axis (Header 8x2) connecting to DB15 receptacle (case connector)

ER1 jumper: To enable, jumper center pin and ENABLE. To disable, jumper center pin and ER1. ER1 must be jumpered either enabled (left and middle pin)or disabled (right and middle pin).

The three other groups of connectors are defined in a similar way for use with Y, Z and X2/A-axis.

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Molex Connectors on the Left Edge

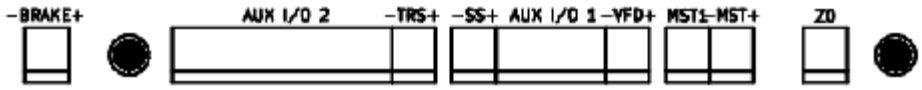

Figure 4: AUX I/O 1 is a 5-pin and AUX I/O 2 is a 10-pin connector. All others are 2-pin connectors.

Connectors	**Description/Function**
Z0	Probe connector
MST1	Normally open relay controlled continiuty for Mister control
-MST+	Mister control signal (12 VDC) to activate solenoid valve or relay
-VFD+	Spindle control signal (12 VDC) to relay
AUX I/O 1	Normally open spindle control and 0-10 VDC spindle speed signal
-SS+	VFD signal indicating spindle stop (24VDC) or spindle running (0 VDC)
-TRS+	Tool release signal (12 VDC) to activate solenoid valve or relay
AUX I/O 2	Tool changer control signals
-BRAKE+	Magnetic brake, 24 VDC when enabled (max 1A)

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Molex Connectors on the Right Edge

Figure 5: ES2 connects to controller case ESTOP. ESTOP:s on the side of gantry connect to ES1. If there are no ESTOPS on the side of gantry, JP1 must be jumpered.

Connectors	Description/Function
+ZCR-	Enable Zero Crossing Relay (12 VDC)
ES2	ESTOP pushbutton on controller case
ES1	ESTOP pushbutton on gantry (jumper if there is no pushbuttons on gantry)
+12V-	12 VDC supply (max 1A)
+5V-	5 VDC supply (max 1A)
PC-POWER SUPPLY	Standard PC Power supply connector providing 12 and 5 VDC.

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Ribbon Cables to Box Headers

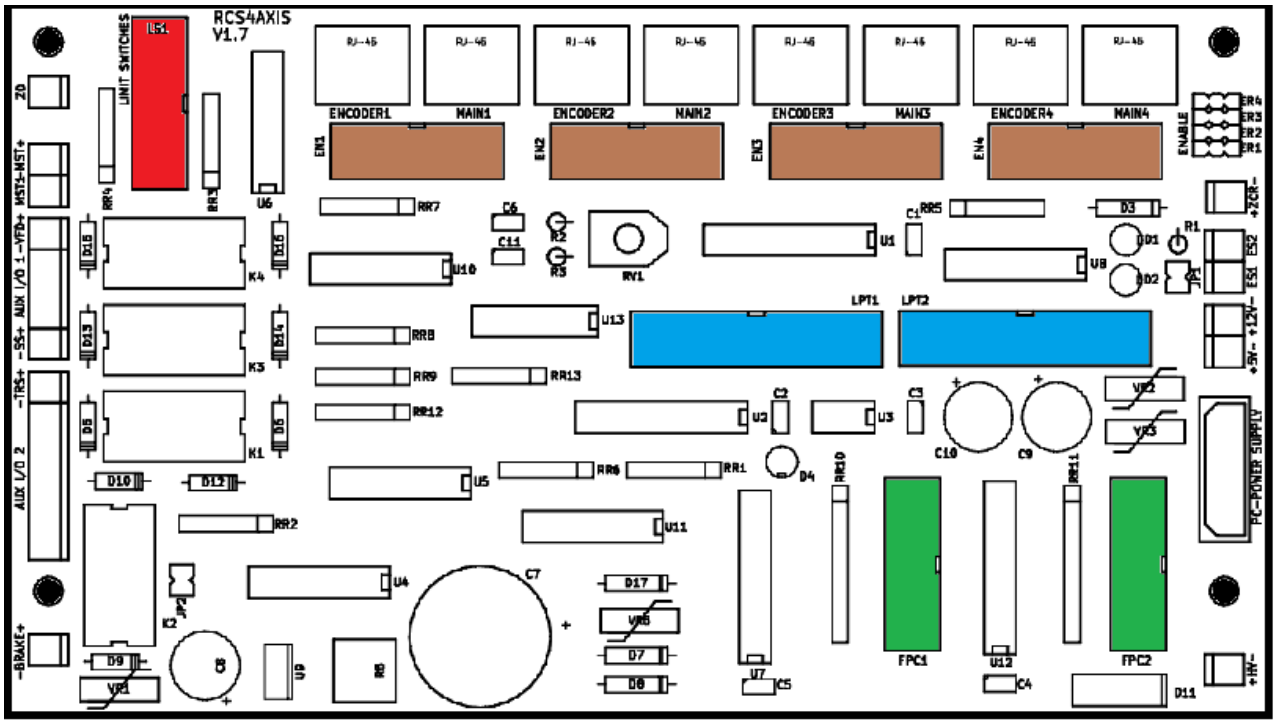

Figure 6: Not all ribbon connectors are used with every system.

Connectors	Description/Function
LIMIT SWITCHES	Limit or home switch connector (Header 8x2)
EN1 ... EN4	Encoder header to DB15 encoder connector (Header 8x2)
LPT1 and LPT2	Parallel port one and two (Header 13x2)
FPC1 and FPC2	Front panel LED connectors (Header 8x2)

Jumpers and Potentiometer

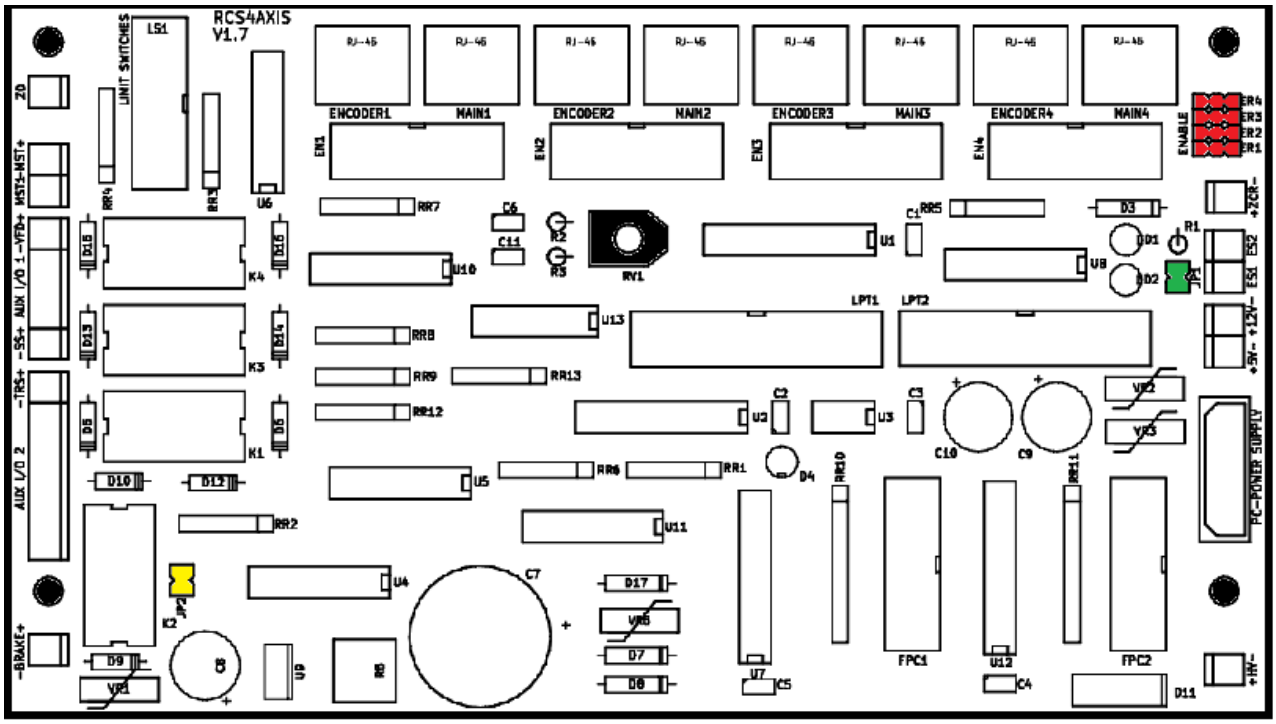

Figure 7: The potentiometer RV1 (black) is used for adjusting the 0-10VDC for spindle speed control. In rare cases, there is a need to adjust this potentiometer in the field.

Jumper(s)	Description
JP1 (green)	Table ESTOP. Jumper if no ESTOP pushbutton on gantry.
JP3 (yellow)	Used with ATC. Tool release should happen only when spindle has stopped. Jumper if not used.
ER1 ... ER4 (red)	Enable only if the axis is used.

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Motor Tuning

Mach3 user manual explains the procedure for motor tuning. If the encoder gain values from the old system are known the 'Steps/in' values can be calculated by:

Steps/inch = 1/(8*Enc_gain)

This equation is valid for all axes as well as belt and rack and pinion machines.

Example: Z-axis encoder gain for a 5mm (0.197") pitch ballscrew and 2048 line encoder will be

ENC_GAIN = 0.197/2048/4 = **0.00002400344488**

The steps per inch will be

Steps/in = 1/(8*0.00002400344488) = **5207.6**

You can also verify/adjust the value of steps/in for each axis by measurements.

1) Start the controller and allow to boot normally.
2) Home the router.
3) Install a sharply pointed tool in an appropriate collet (a small cutting tool or pencil etc).
4) Find a known accurate measuring device (a new high quality tape measure). Lay the tape measure on the router table surface, extend tape measure to the full effective length of the table surface.
5) Position the pointed tool to the front of the machine over an easily read index on the tape measure (1in, 2in, 5in etc.)
6) Set this value to be the machine origin.
7) Jog the machine down the length of the table a desired distance, round numbers are easier (40in, 50in, 100in etc. longer distances provide better accuracy); this distance should be determined using the "relative" option of the "digital read out" (DRO) located in the upper left corner of the screen.
8) Compare this number in the DRO to the value against the tape measure. For most signing applications 1/32" or 1/64" is sufficiently accurate.

Using our two distance values we will create a ratio by which we will adjust out default steps/in

[Corrected Steps/inch] = (old Steps/inch)/(desired distance/measured distance)

Example: The Steps/inch on X-axis is 1928. A command to X-axis by 10 inches move the machine by only 7.5". The correct steps will be

[Corrected Steps/inch] = 1928 (10/7.5) = 2570.6

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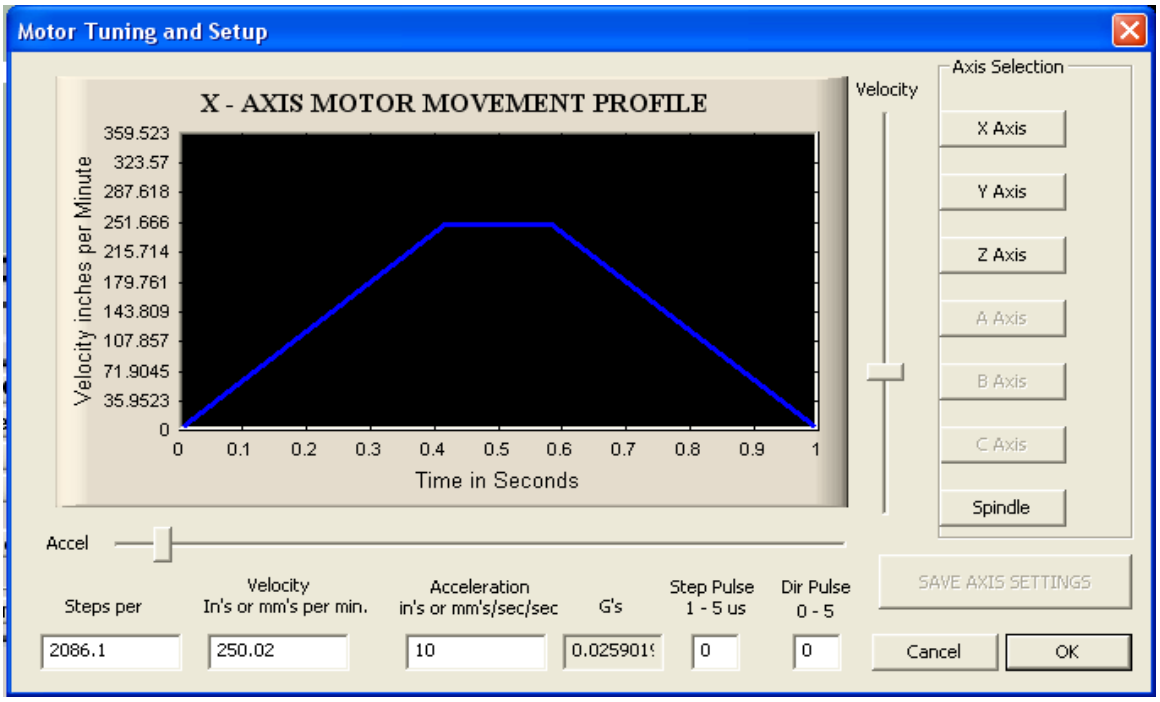

Figure 8: Figure 8: Steps/in, speed and acceleration used for X-axis on a 5'x10' rack and pinion table.

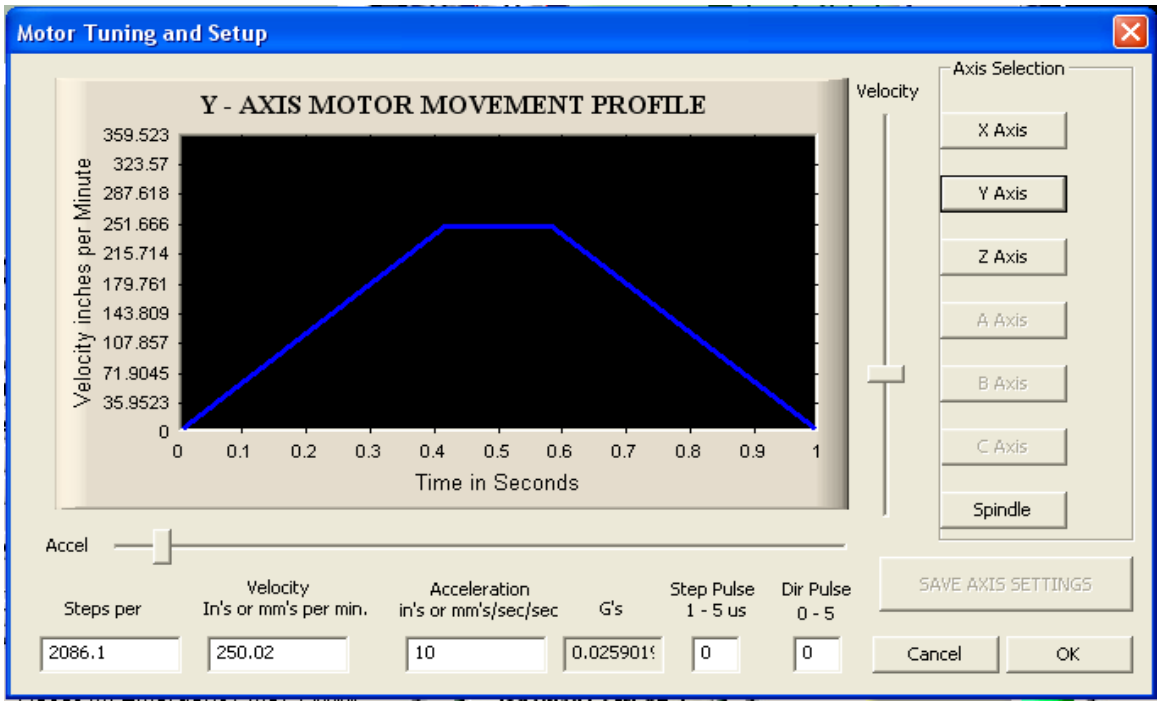

Figure 9: Figure 8: Steps/in, speed and acceleration used for Y-axis on a 5'x10' rack and pinion table.

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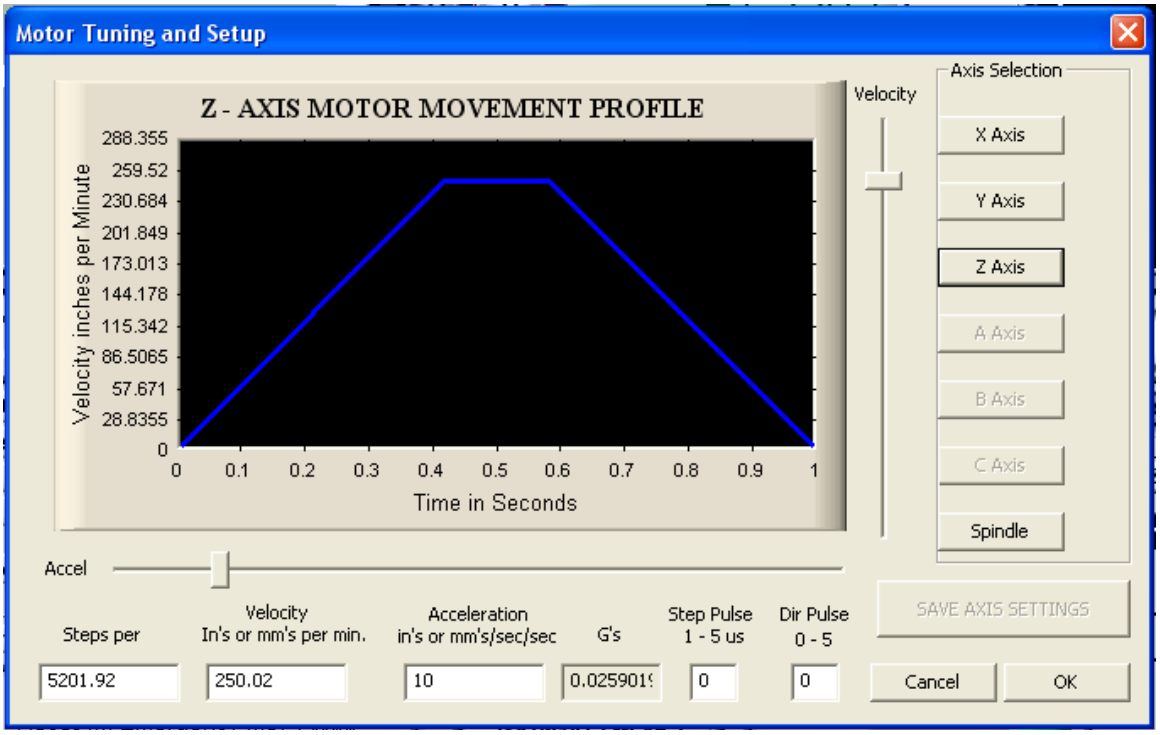

Figure 10: Steps/in, speed and acceleration for a 6" Z-axis holding a 5HP, 18000 RPM max speed Perske spindle.

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Spindle Tuning

Spindle speed is controlled by step signals on pin 1, as per Figure 11, 12 and 20. The VFD control signal will be 0-10 VDC. Set the maximum spindle speed by selecting ***Config-> Spindle pulleys***. In Figure 11, the maximum spindle speed is set for 18,000 RPM. Pulley number is not relevant for VFD speed control. Set the minimum speed to 0 and Ratio to 1.

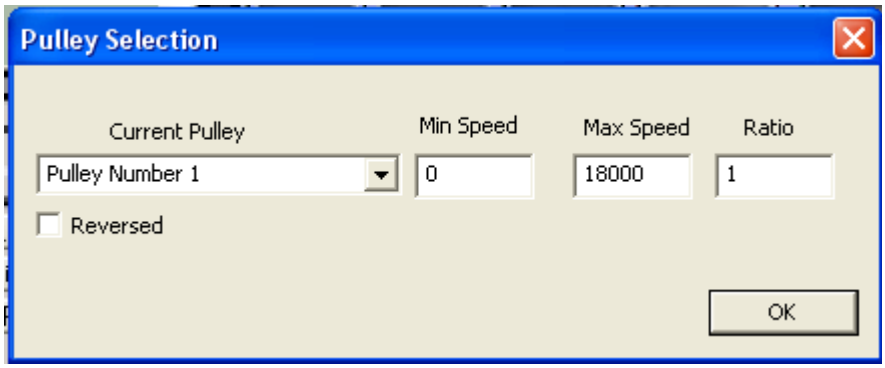

Figure 11: Set the maximum spindle speed.

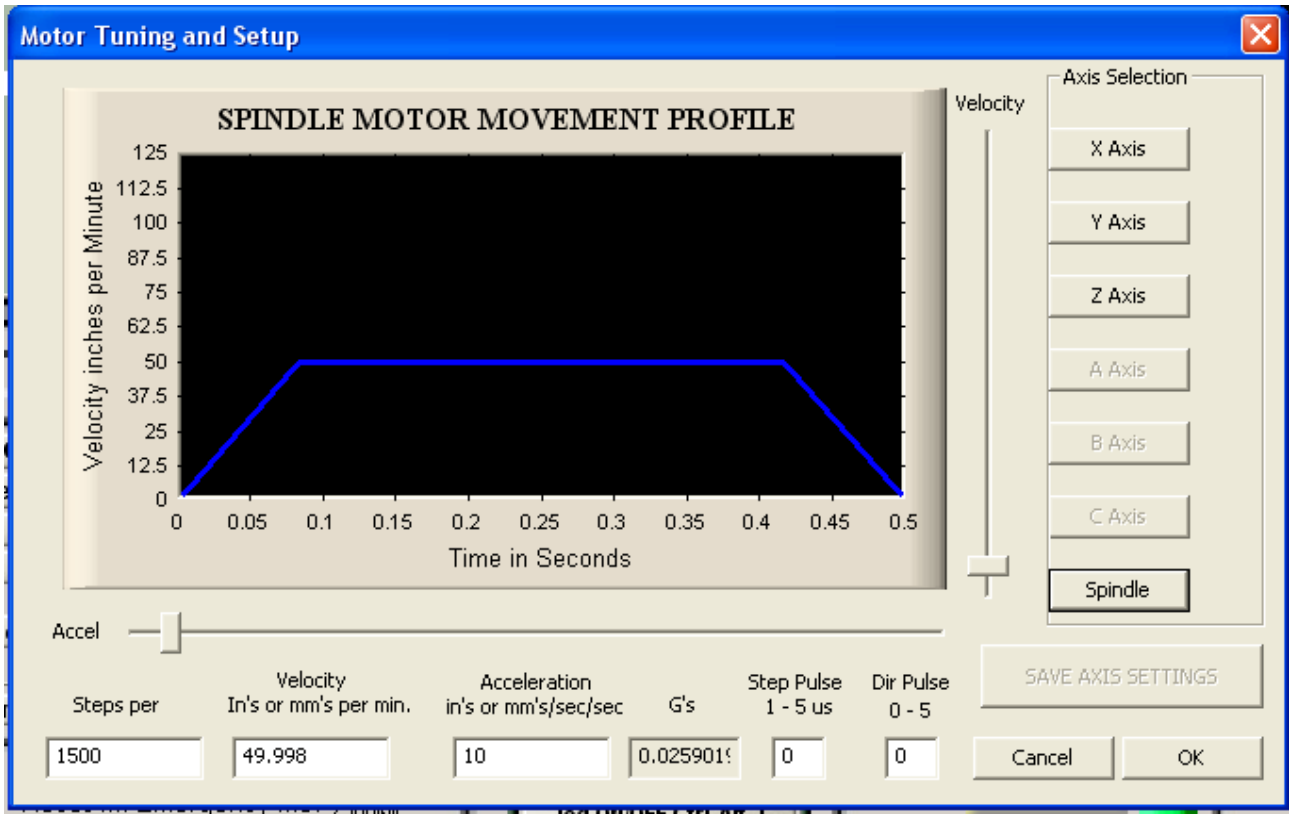

Figure 12: Steps/rev, speed and acceleration values for spindle.

Verify the actual spindle speed at 25%, 50%, 75% and 100%. Minor adjustment to ***Steps per*** revolution should bring you close to 1% accuracy. In rare cases you need to adjust the potentiometer on the board, see Figure7.

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Probe or Z-touch plate setup

Please follow the steps below for activating and setup of probe (Z-touch plate):

1. Make sure pin #15 is setup as per Figure 13. Click on ***Config->Ports&Pins->Inputs***, and configure pin 15 as the "Probe" input, making it Active Low.

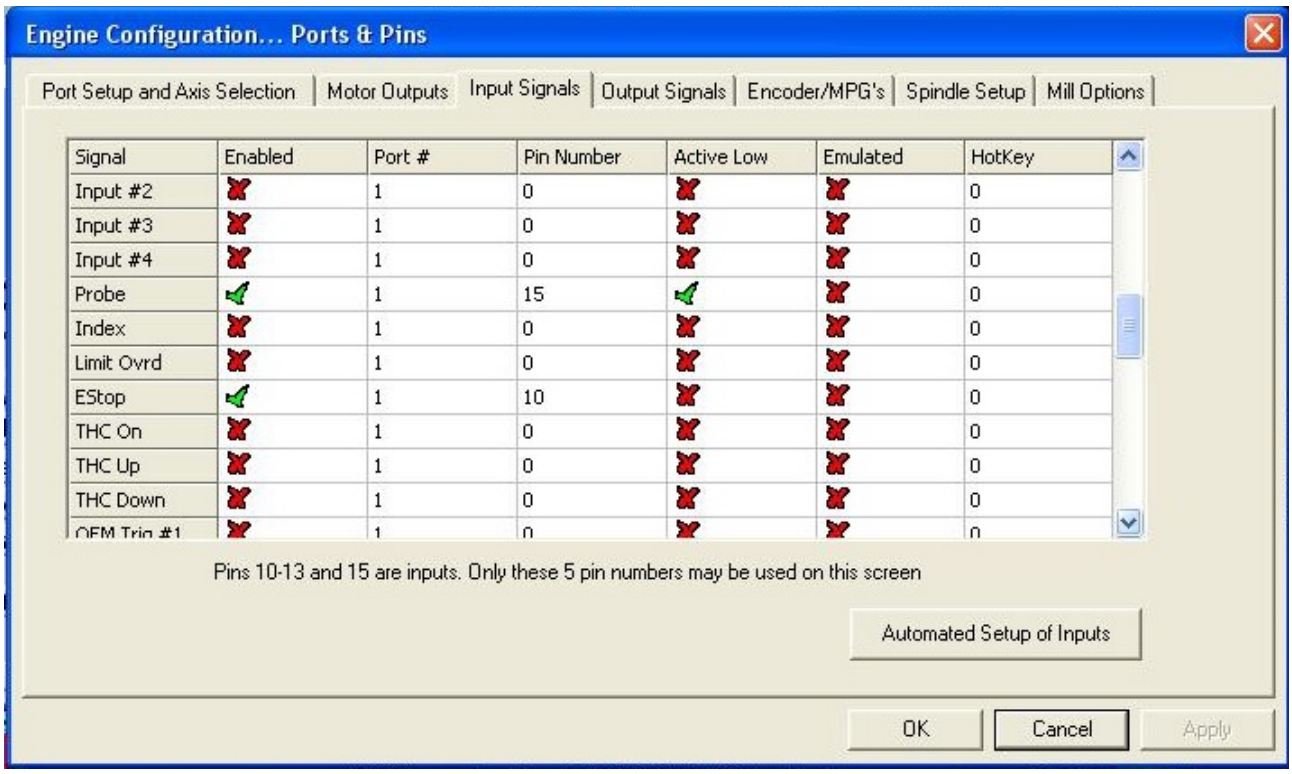
Engine Configuration... Ports & Pins
Port Setup and Axis Selection
Motor Outputs
Input Signals
Output Signals
Encoder/MPG's
Spindle Setup
Mill Options
Signal | Enabled | Port # | Pin Number | Active Low | Emulated | HotKey
Input #2 | 1 | 0
Input #3 | 1 | 0
Input #4 | 1 | 0
Probe | 1 | 15
Index | 1 | 0
Limit Ovrd | 1 | 0
EStop | 1 | 10
THC On | 1 | 0
THC Up | 1 | 0
THC Down | 1 | 0
Pins 10-13 and 15 are inputs. Only these 5 pin numbers may be used on this screen
Automated Setup of Inputs
OK
Cancel
Apply

Figure 13: Probe (Z-touch plate) is hard wired to Pin 15.

2. Verify the operation of the probe by touching the router bit with the Z-touch plate. When Z-touch plate is plugged in, the Z0 LED on the front of case should turn ON. When the plate touches the router bit the Z0 LED should turn off.
3. Click to the Offsets screen, and, in the top-left corner, set the touch plate thickness to the exact thickness of your plate (0.250" or measure the plate thickness).
4. Click on ***Operator->EditButtonScript.*** At this time the ***Auto Tool Zero*** button start blinking, see Figure 14.

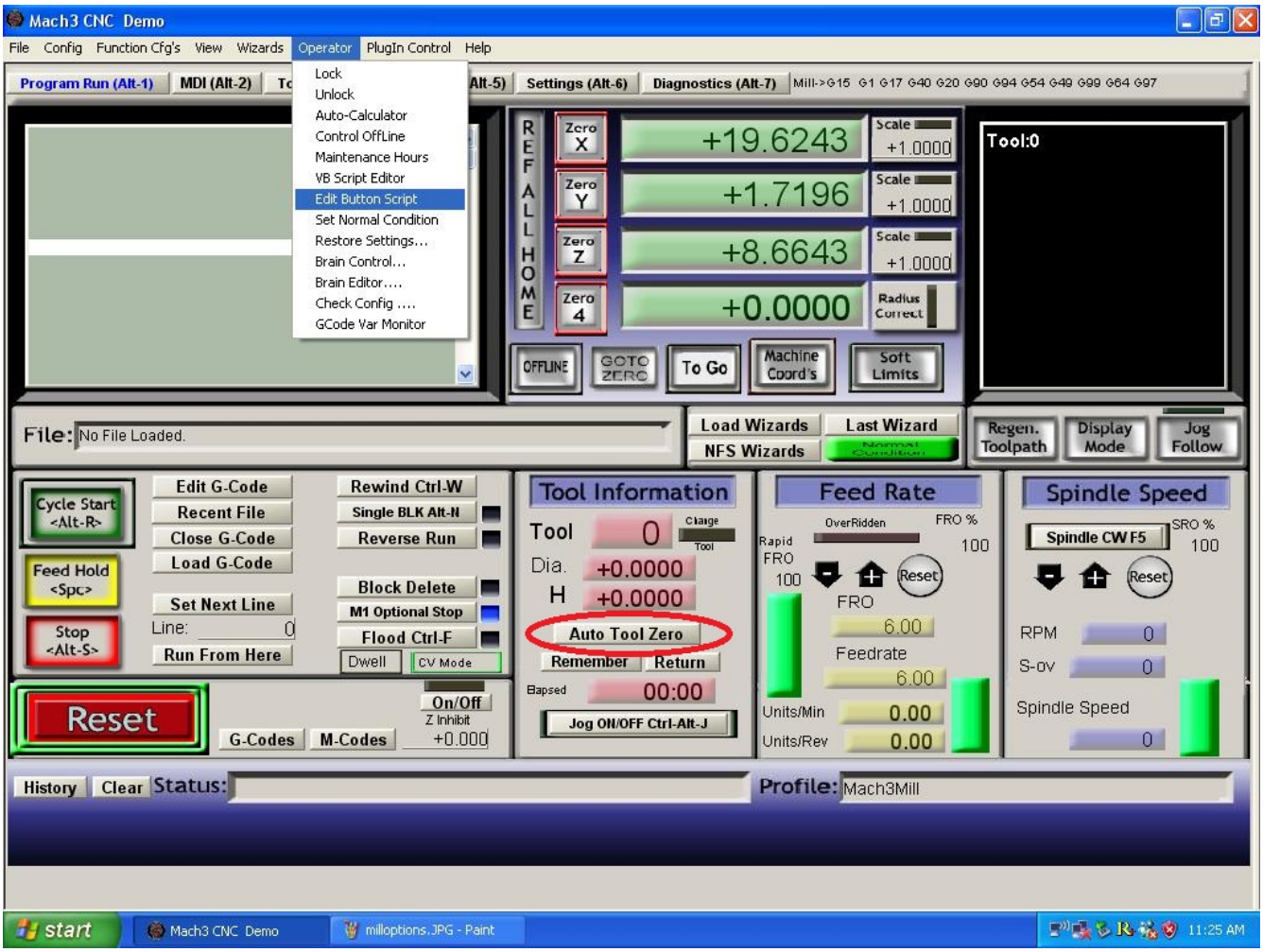

Figure 14: After selecting "Edit Button Script", the "Auto Tool Zero" button will blink.

5. Click on the **"Auto Tool Zero"** button to open VB editor, see Figure 15.

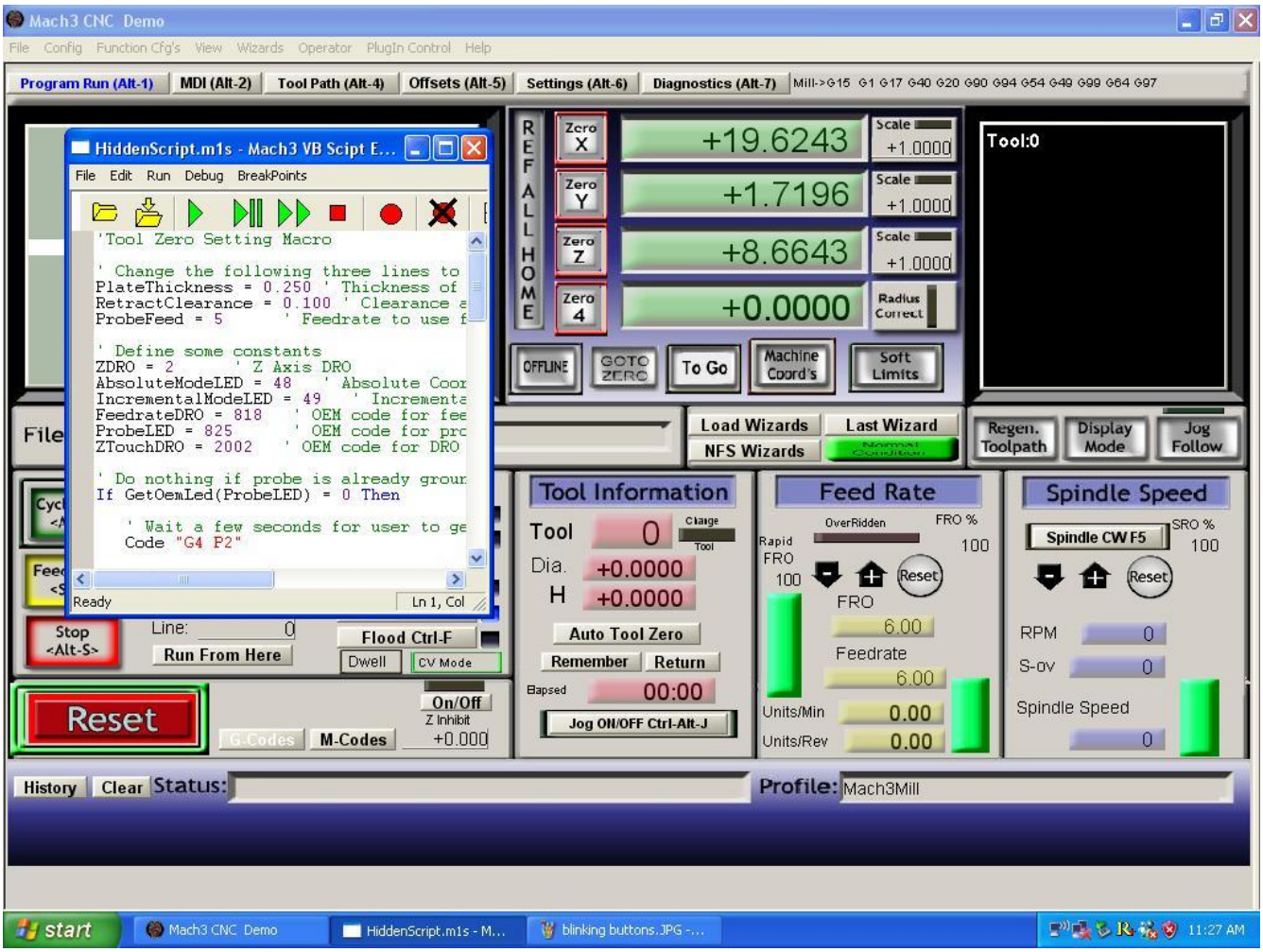

Figure 15: Copy and Paste the script for "Auto Tool Zero" in the editor and save the macro.

6. When the VB editor opens, delete the lines of code, and paste in the macro explained below:

```
'Tool Zero Setting Macro
PlateThickness = 0.250 ' Thickness of touch plate
RetractClearance = 0.100 ' Clearance above touch plate to retract to
ProbeFeed = 5       ' Feedrate to use for probing
' Mach3 DRO constants
ZDRO = 2       ' Z Axis DRO
AbsoluteModeLED = 48    ' Absolute Coordinate Mode LED
IncrementalModeLED = 49    ' Incremental Coordinate Mode LED
FeedrateDRO = 818    ' OEM code for feedrate DRO
ProbeLED = 825       ' OEM code for probe input LED
```

```
ZTouchDRO = 2002    ' OEM code for DRO that holds Z touch position
' Do not do anything if the probe is already grounded
If GetOemLed(ProbeLED) = 0 Then
' Wait a few seconds for user to get the touch plate in place
Code "G4 P2"
' Save the current value of feedrate
CurrentFeed = GetOemDRO(FeedrateDRO)
' Save the current coordinate mode
AbsMode = GetOemLED(AbsoluteModeLED)
' Set the absolute coordinate mode
Code "G90"
' Zero Z DRO
Call SetDro (ZDRO, 0.0000)
' Pause for DRO to update
Code "G4 P0.5"
' Do the touch move
Code "G31 Z-0.5 F" & ProbeFeed
' Wait for it to complete i.e. moving down slowly till router biy touches the ' '
plate
While IsMoving()
Wend
' Delay for a little bit
Code "G4 P0.5"
' Get the Z position where probe input triggered
ZProbePos = GetVar(ZTouchDRO)
'Retract to touch position
Code "G0 Z" & ZProbePos
' Wait for it to complete
While IsMoving ()
Wend
' Set Z DRO to touch plate thickness
Call SetDro (ZDRO, PlateThickness)
' Pause for DRO to update
Code "G4 P0.5"
' Retract Z to SafeZ, if enabled, else to RetractClearance above plate
If(IsSafeZ() = 1) Then
  SafeZ = GetSafeZ
If  SafeZ  > PlateThickness Then
```

```
  GotoSafeZ()
End If
Else
  RetractHeight = PlateThickness + RetractClearance
  Code "G0 Z" & RetractHeight
End If
' Display the message
Code "(Z axis is now zeroed)"
' Restore feedrate to original value
Code "F" & CurrentFeed
' Restore coordinate mode to original value
If AbsMode = 0 Then
   Code "G91"
End If
Else
   Code "(Z-touch plate is grounded, check connection and try again)"
End If
Exit Sub
```

7. Save the macro file with its default file name.
8. To test the macro, put the Z-touch plate on the surface of the work right beneath the spindle. Then click on the "Auto Tool Zero" button. The spindle should slowley go down till it touches the Z-touch plate. After recording the positon as Z0, it should retract to its original position. When you do this setup for the first time, stay close to ESTOP button to stop the machine if anything is not done correctly.

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Mach 3 Software Setup

The parallel ports pins are hard wired to the RCS4AXIS connectors. Pins have defined functions as per this document. You need to install Mach 3 on a Windows based computer with parallel port. For Mach 3 software download, minimum requirement for PC and installation instructions visit:

http://www.machsupport.com/

If you replace the original **Mach3Mill.xml** with the one from the link:

http://ridgecontrolsystems.com/CNC-controller/Mach3Mill.xml

(Right click with the mouse and select "Save Link as ...")

You should have your machine setup as per explained below:

In order to assign parallel port pins to correct values click on ***Config*** and select ***Ports and Pins***, see Figure9.

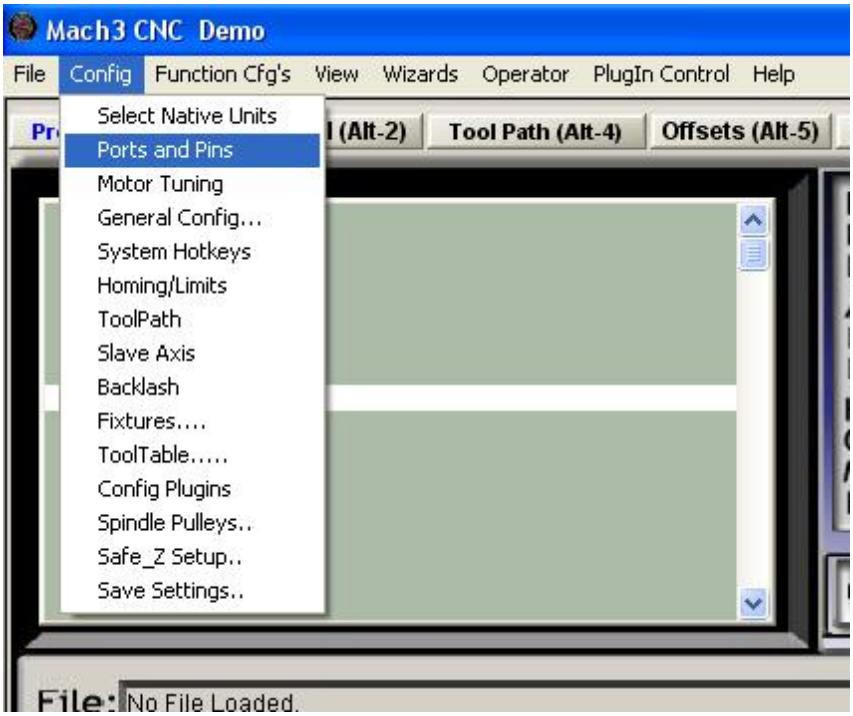

Figure 16: Main setttings of RCS4AXIS parameters with Mach3 software.

1) Setup the Port #1, Port #2 address and Kernel speed, as per Mach 3 user manual.

2) Enable only those motors that are used on your machine. The board supports up to 4 axes plus spindle. If the the machine JOG is not working in the intended direction, you need to reverse the direction of motion by changing "Dir Active Low" from checked to unchecked or vice versa. The port pins are hard

wired to RJ45 plugs on the board. Each pair of ports (2&3, 4&5, 6&7 and 8&9) control one axis. The controller is built to use the suggested setup in Figure 16.

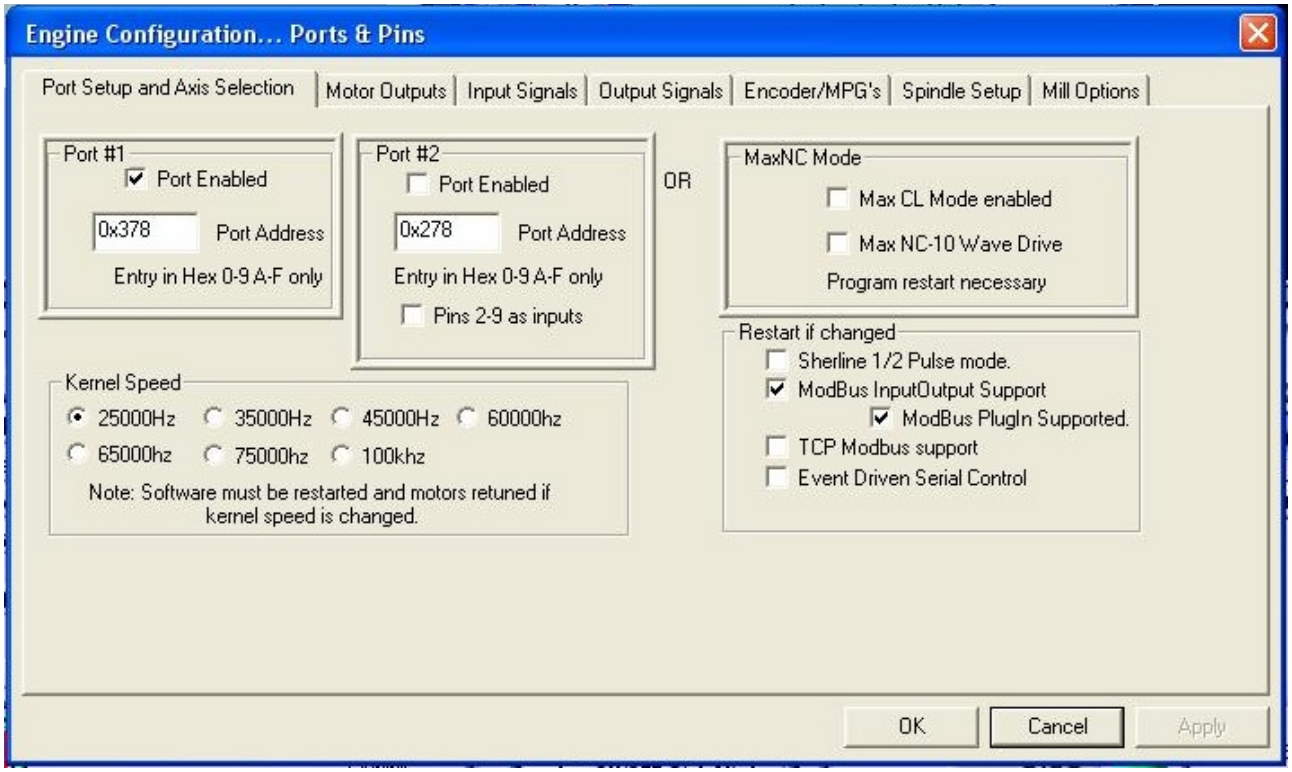

Figure 17: Enable port(s), MODBUS and select Kernel speed.

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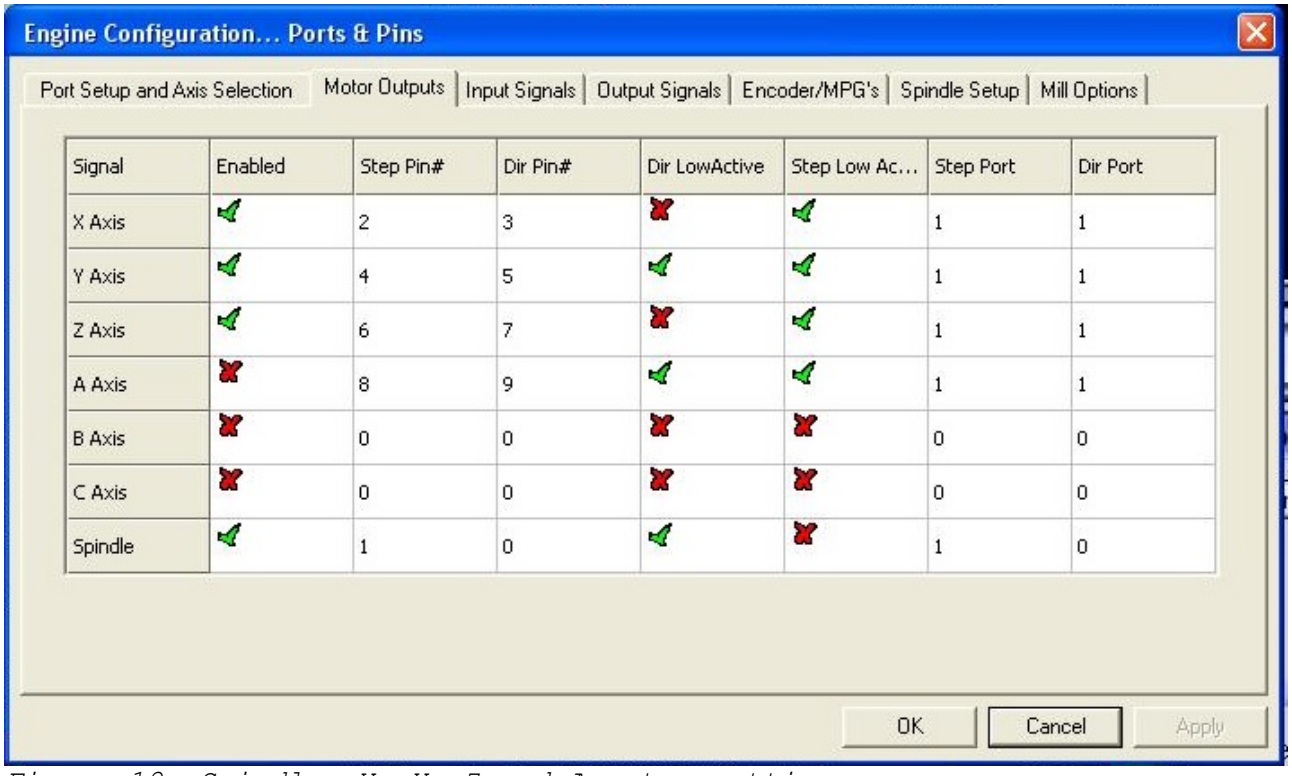

Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac...	Step Port	Dir Port
X Axis	✓	2	3	✗	✓	1	1
Y Axis	✓	4	5	✓	✓	1	1
Z Axis	✓	6	7	✗	✓	1	1
A Axis	✗	8	9	✓	✓	1	1
B Axis	✗	0	0	✗	✗	0	0
C Axis	✗	0	0	✗	✗	0	0
Spindle	✓	1	0	✓	✗	1	0

Figure 18: Spindle, X, Y, Z and A motor settings.

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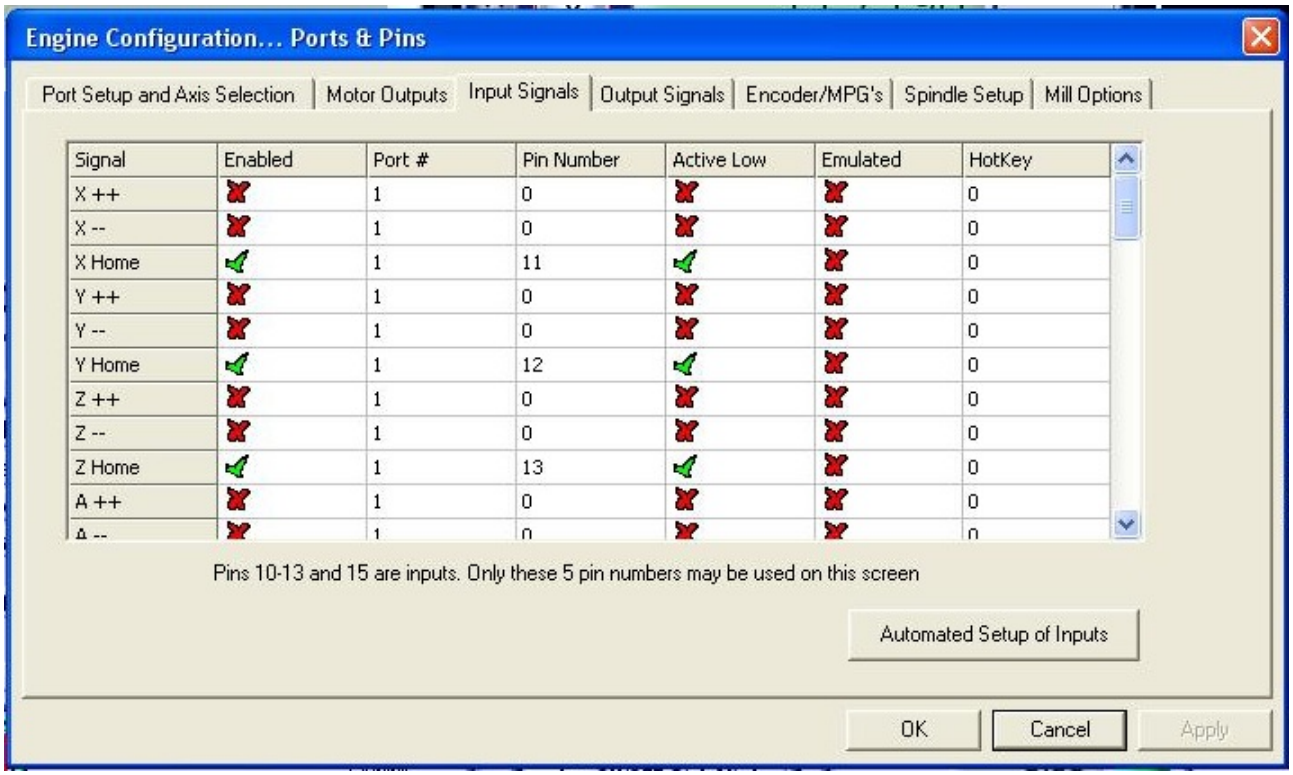
Engine Configuration... Ports & Pins
Port Setup and Axis Selection
Motor Outputs
Input Signals
Output Signals
Encoder/MPG's
Spindle Setup
Mill Options
Signal | Enabled | Port # | Pin Number | Active Low | Emulated | HotKey
X ++ | 1 | 0 | 0
X -- | 1 | 0 | 0
X Home | 1 | 11 | 0
Y ++ | 1 | 0 | 0
Y -- | 1 | 0 | 0
Y Home | 1 | 12 | 0
Z ++ | 1 | 0 | 0
Z -- | 1 | 0 | 0
Z Home | 1 | 13 | 0
A ++ | 1 | 0 | 0
Pins 10-13 and 15 are inputs. Only these 5 pin numbers may be used on this screen
Automated Setup of Inputs
OK
Cancel
Apply

Figure 19: Input 11, 12 1nd 13 are hard wired to limit switches on X, Y and Z-axis.

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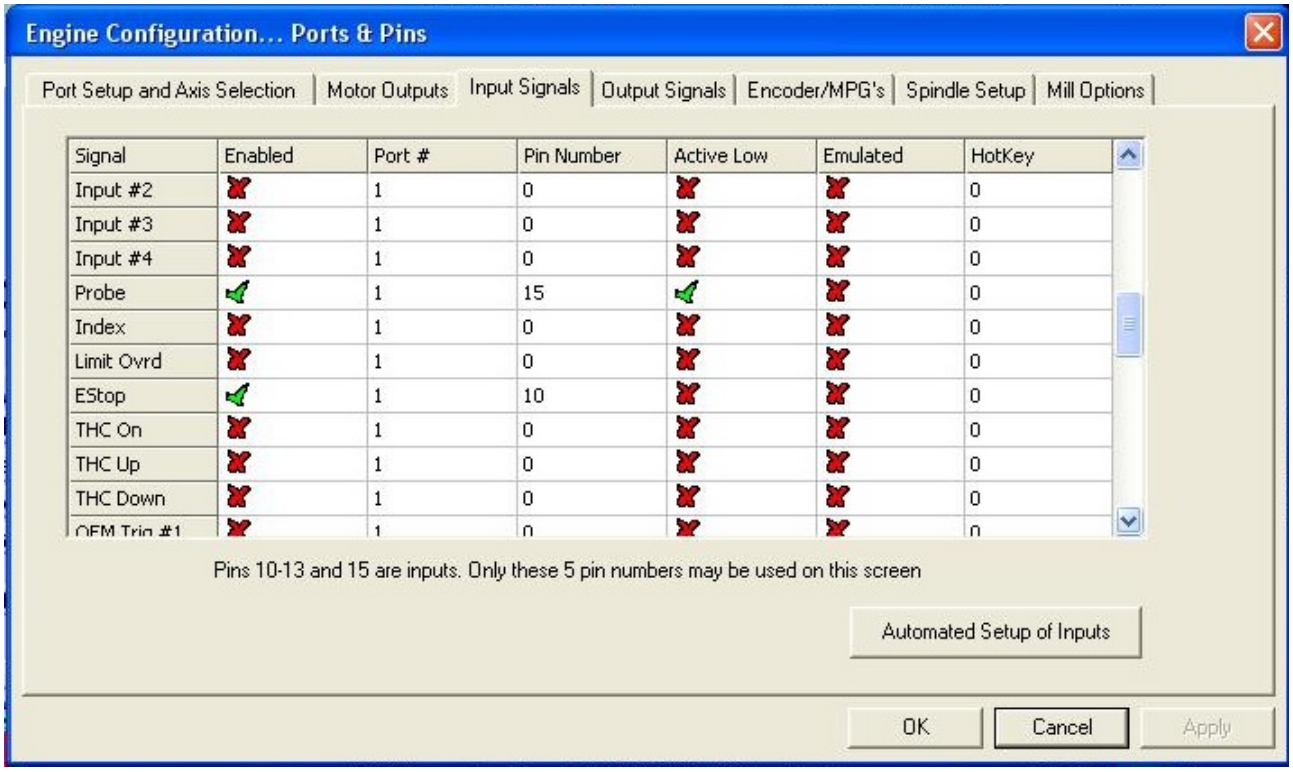
Engine Configuration... Ports & Pins
Port Setup and Axis Selection
Motor Outputs
Input Signals
Output Signals
Encoder/MPG's
Spindle Setup
Mill Options
Signal | Enabled | Port # | Pin Number | Active Low | Emulated | HotKey
Input #2 | 1 | 0
Input #3 | 1 | 0
Input #4 | 1 | 0
Probe | 1 | 15
Index | 1 | 0
Limit Ovrd | 1 | 0
EStop | 1 | 10
THC On | 1 | 0
THC Up | 1 | 0
THC Down | 1 | 0
Pins 10-13 and 15 are inputs. Only these 5 pin numbers may be used on this screen
Automated Setup of Inputs
OK
Cancel
Apply

Figure 20: Input 15 is hard wired for probe (Z-touch plate) and input 10 for ESTOP.

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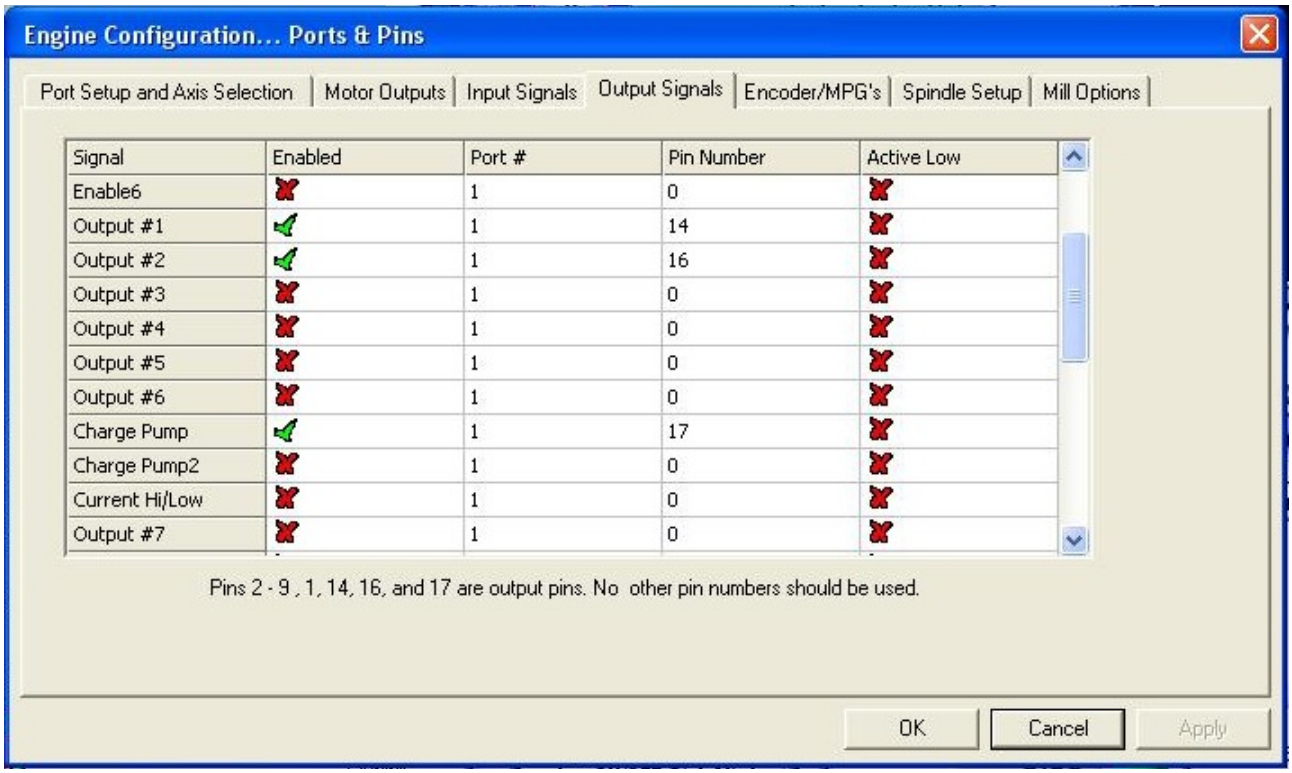

Figure 21: Output #1 is hard wired to spindle ON/OFF, output #2 to mister ON/OFF. Pin 17 generates the charge pump signal.

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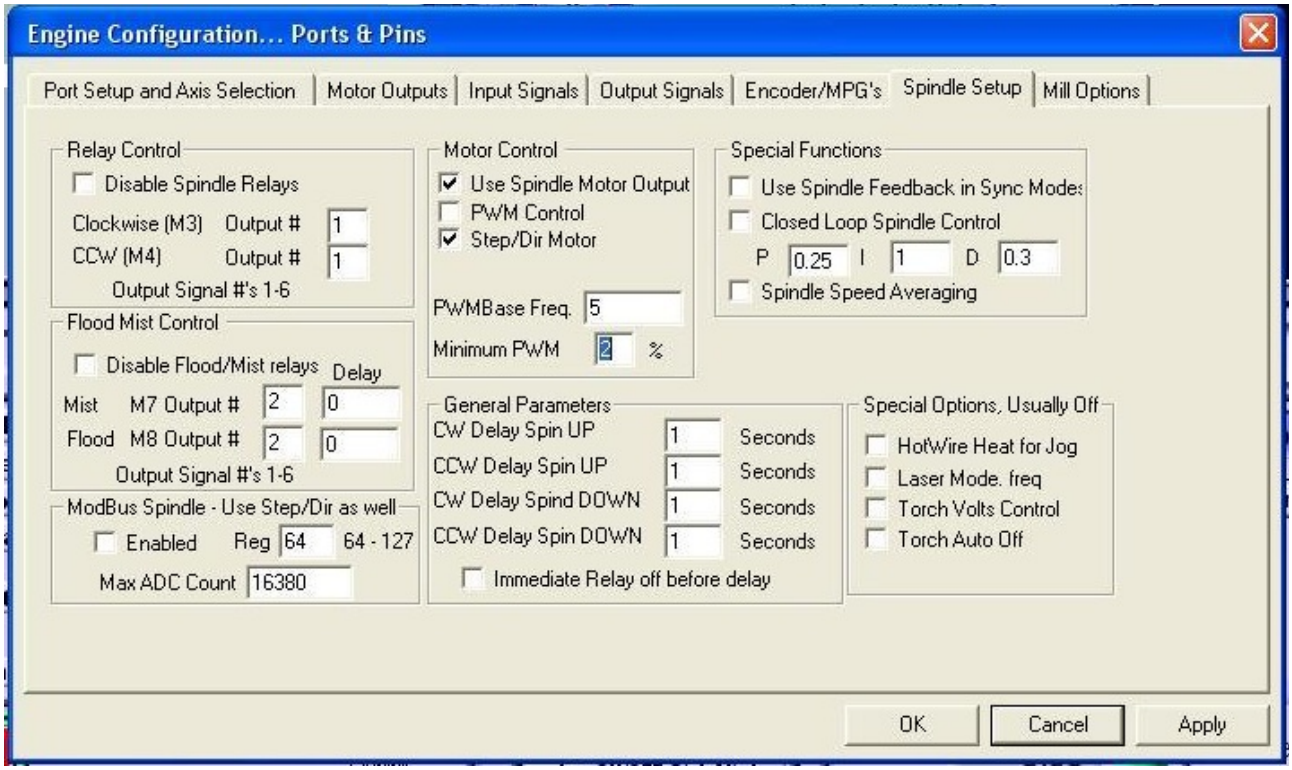

Figure 22: M3 and M4 will turn the spindle ON. The router spindle will always turn only in one direction. M7 and M8 will turn the mister ON. Under motor control check the boxes for "Use Spindle Motor Output" and "Step/Dir Motor".

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Normal Operation of Controller

At power up, you should see the following:

1) The light of ON/OFF switch should turn ON.
2) If machine is away from home position of any axis, the LIM status light for that axis should be ON otherwise OFF.
3) If Z-touch plate (Probe) is plugged in, th Z0 light should be ON.
4) SPINDLE should be OFF.
5) MISTER should be OFF.
6) SPINDLE STOP should be ON.
7) If any of the ESTOP buttons (one at the front of controller and possibly two on the side of gantry) is pushed in then:

FAULT: ON

ESTOP: OFF

HV: OFF

At this time there is no power to the drives, therefore X and Y axis can be easily pushed by hand back and forth. However, the Z-axis should hold if the magnetic brake is engaged. By pulling all ESTOP buttons out, you should see that:

FAULT: OFF

ESTOP: ON
HV: ON

Now the drives are powered and all axes should be holding their positions. The magnetic brake on the Z-axis is still engaged. At this time the "Reset" button in Mach software can be pushed. You should see:

BRAKE: ON

Which means that magnetic brake is released and all axes are ready for JOG or move command.

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Drive tuning parameters, PID values

In case the drives need a programmer, the drive programmer will be shipped inside a tagged plastic bag in the controller.

Whale 3 Servo Drive Parameters

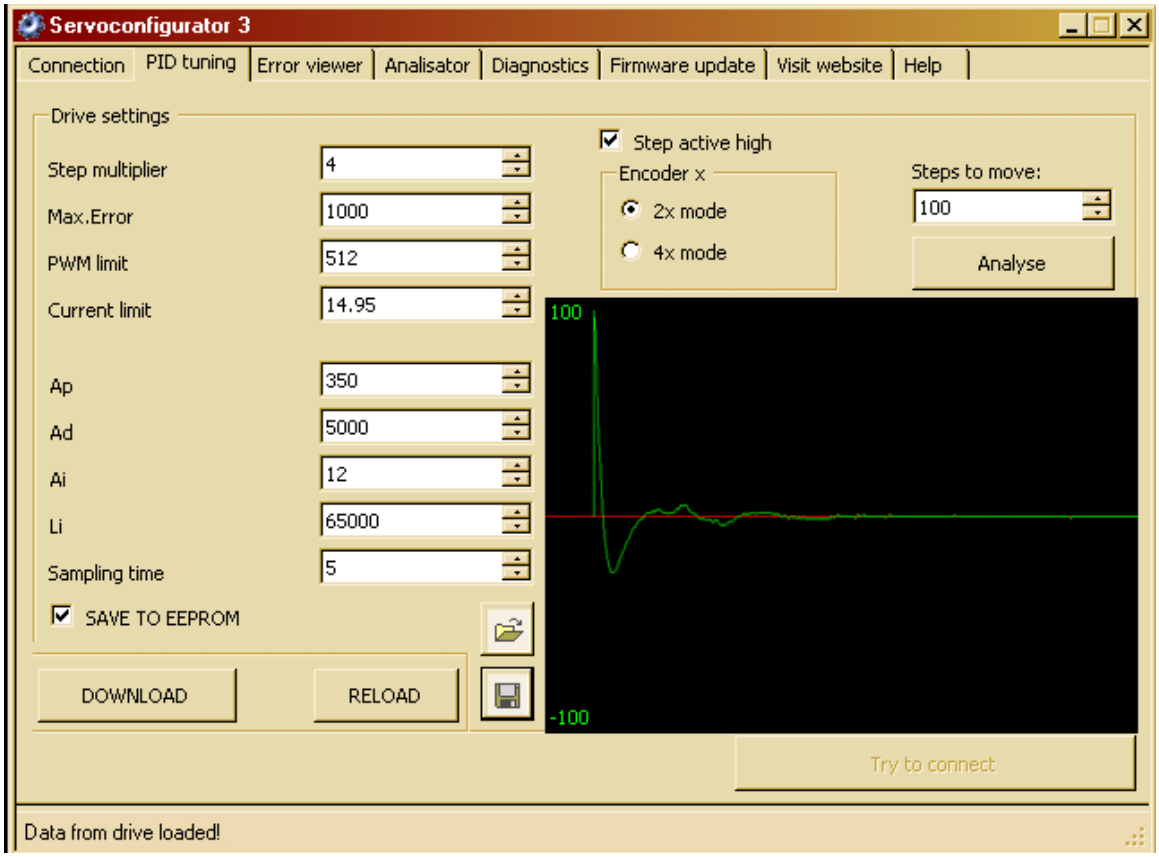

Figure 23: Typical PID values for Whale 3 servo drive. For the actual values used with your machine, see chart below.

For detalied info regarding the tuning and PID setting of this drive see manufacturer's user manual. The setting used for Astromec (T31-25) and MagMotor (C33-E-300FE and C33-E-300FEB) were as the picture below:

X-axis	**Y-axis**	**Z-axis**
Encodermode = 2X Stepmultiplier = 4 LockoutError = 1000 PWMlimit = 512 Currentlimit = 15.0 Ap = 440 Ad = 7000 Ai = 12 Li = 55000 Sampling = 4	Encodermode = 2X Stepmultiplier = 4 LockoutError = 1000 PWMlimit= 512 Currentlimit= 15.0 Ap = 350 Ad = 5000 Ai = 12 Li = 65000 Sampling = 5	Encodermode = 2X Stepmultiplier = 4 LockoutError = 1000 PWMlimit = 512 Currentlimit= 15.0 Ap = 440 Ad = 7000 Ai = 12 Li = 55000 Sampling = 4

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DG2S, DG3S and DG4S Servo Drives Parameters

For detalied info regarding the tuning and PID setting of this drive see manufacturer's user manual. The setting used for Astromec (T31-25) and MagMotor (C33-E-300FE and C33-E-300FEB) were as the picture below:

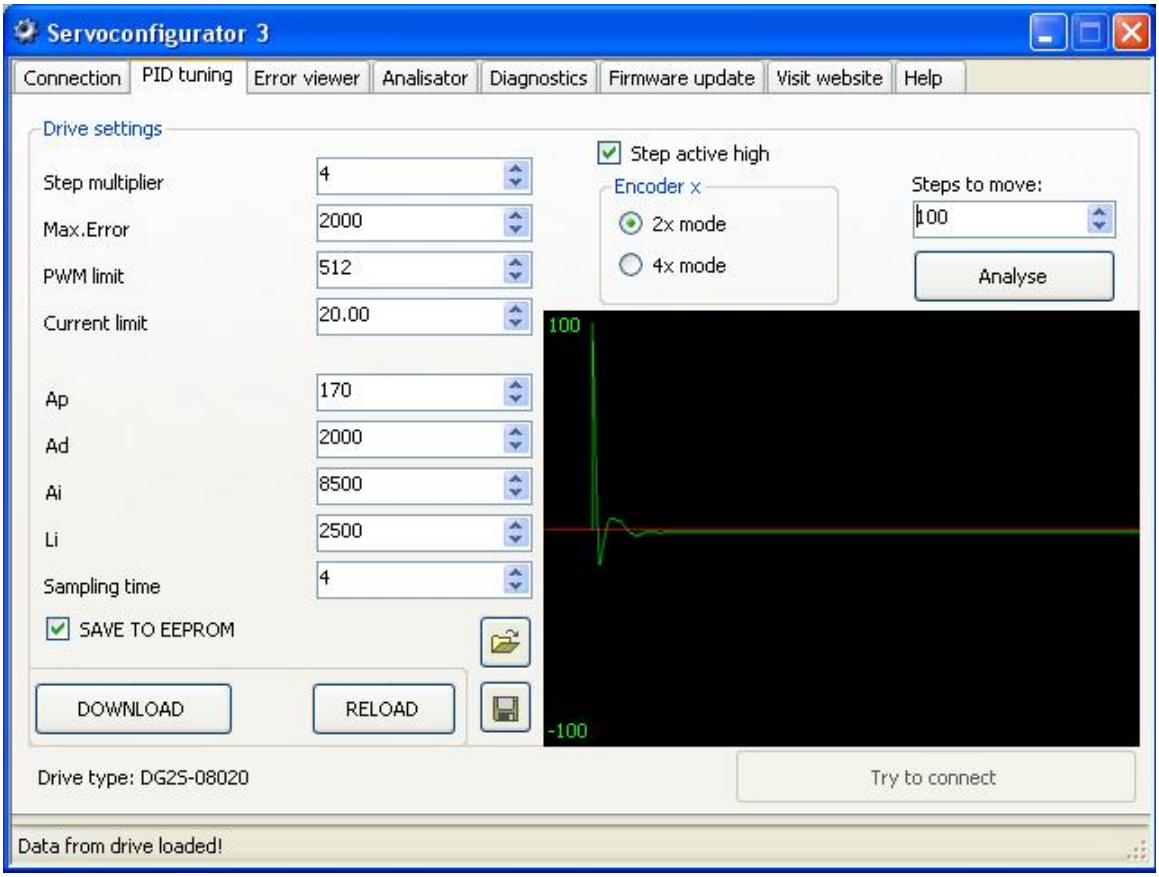

Figure 24: Typical PID values for DG2S servo drive. For the actual values used with your machine, see chart below.

X-axis	**Y-axis**	**Z-axis**
[PID settings] Stepactive= True Encodermode= 2X Stepmultiplier= 4 LockoutError= 2000 PWMlimit= 512 Currentlimit= 20 Ap= 170 Ad= 2000 Ai= 8500 Li= 2500 Sampling= 4	[PID settings] Stepactive= True Encodermode= 2X Stepmultiplier= 4 LockoutError= 2000 PWMlimit= 512 Currentlimit= 20 Ap= 170 Ad= 2000 Ai= 8500 Li= 2500 Sampling= 4	[PID settings] Stepactive= True Encodermode= 2X Stepmultiplier= 4 LockoutError= 2000 PWMlimit= 512 Currentlimit= 20 Ap= 170 Ad= 2000 Ai= 8500 Li= 2500 Sampling= 4

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The same values can be used for Dynetic motors on X and Y-axes.
For Dynetic motors on Z-axis change **Ap to 145** and **Ai to 8000** for better performance.

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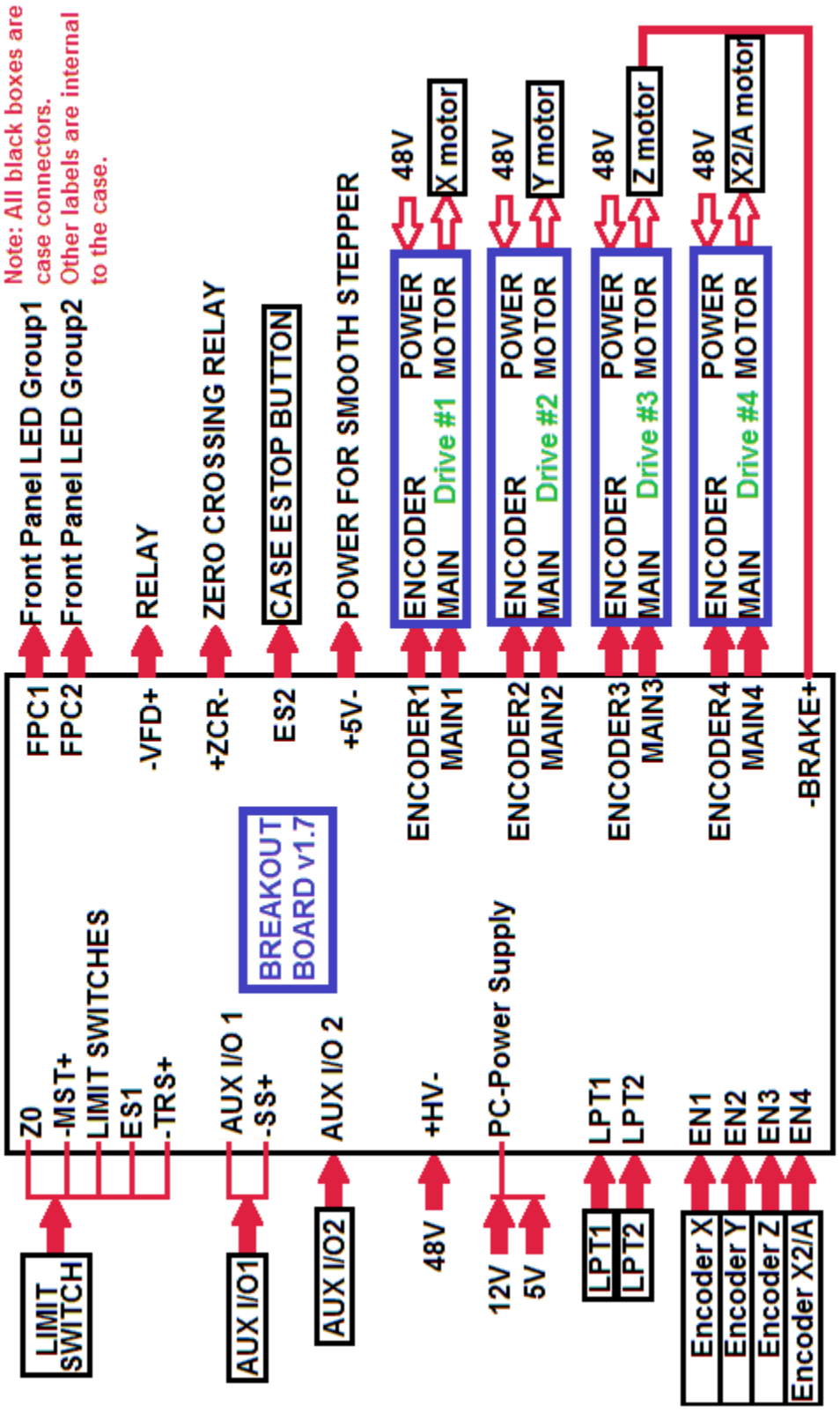
Wiring Information and Schematics



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Power Supplies

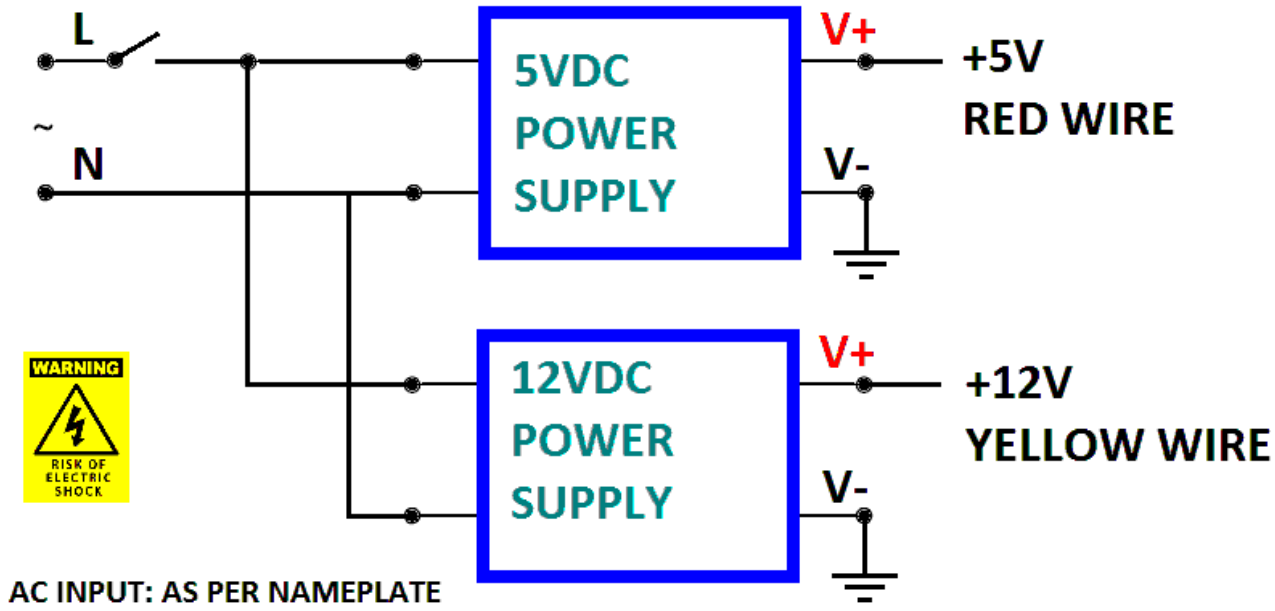

Figure 25: Turn ON the PC first, then controller. After the controller switched ON, both 5VDC and 12VDC should be available at the board.

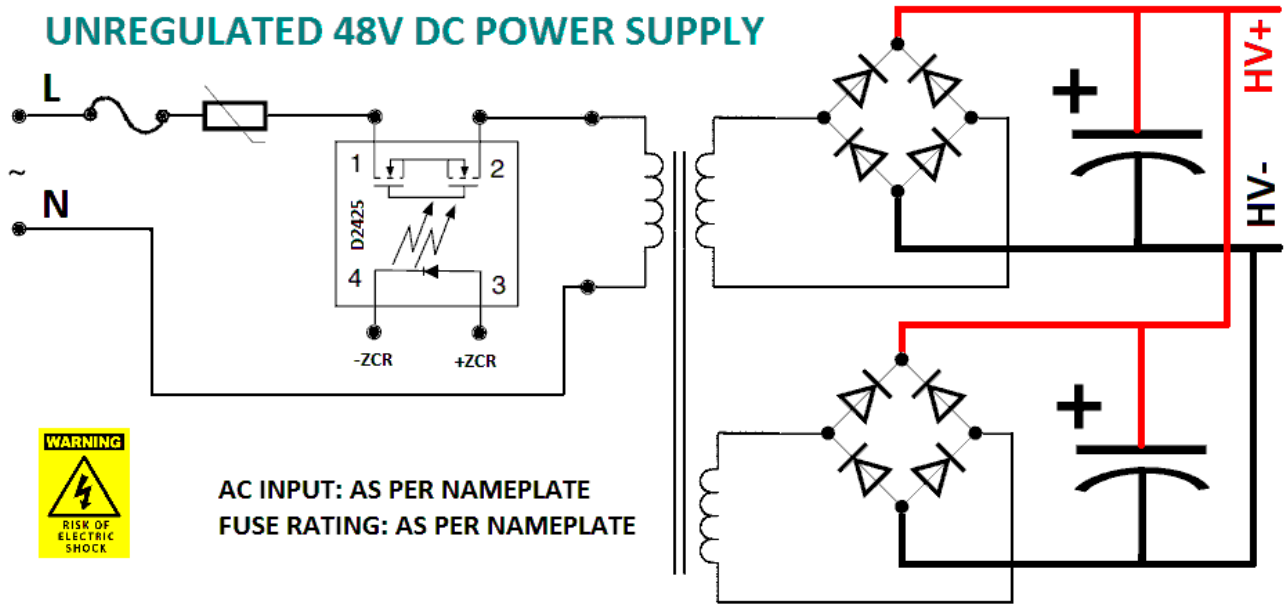

Figure 26: The HV (48 VDC)should be available only when ESTOP:s are pulled out and the "charge pump" signal is sent to the controller.

48 VDC is used to drive DC brush motors. For drive wiring see the manufacturer's user manual.

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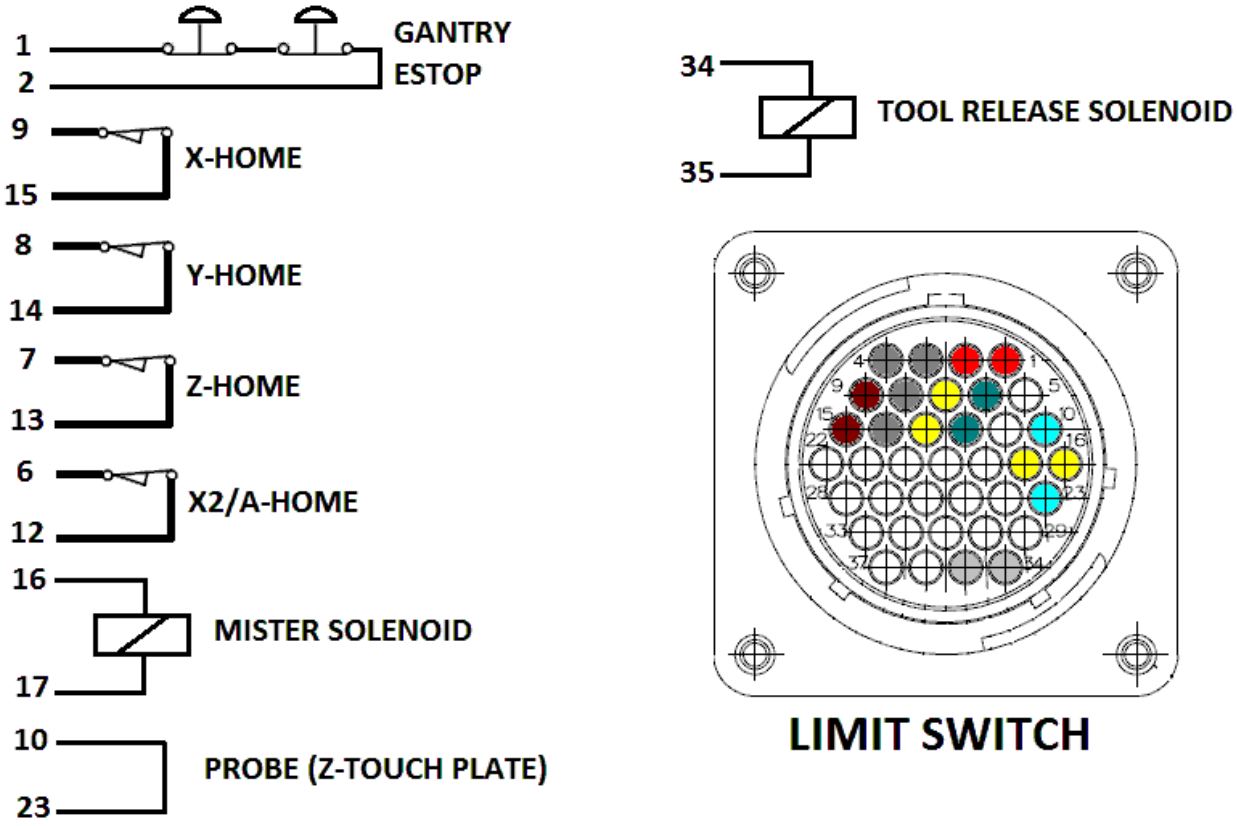

Figure 27: LIMIT SWITCH connector signals.

Internal connections of LIMIT SWITCH receptacle

Signal Description	Limit Switch Connector PIN#	Breack out board connection
Gantry ESTOP	1 & 2	ES2: PIN 1 & 2
X-HOME	9 & 15	LIMIT SWITCH 1 & 2
Y-HOME	8 & 14	LIMIT SWITCH 3 & 4
Z-HOME	7 & 13	LIMIT SWITCH 5 & 6
X2/A-HOME	6 & 12	LIMIT SWITCH 7 & 8
MISTER SOLENOID	16 & 17	-MST+
PROBE (Z-TOUCH PLATE)	10 & 23	Z0
TOOL RELEASE SOLENOID	34 & 35	-TRS+

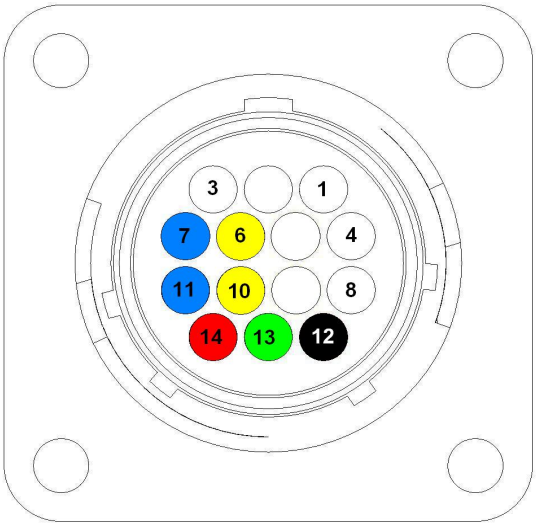

Figure 28: AUX I/O 1 connector.

Internal connections of AUX I/O 1

Signal Description	AUX I/O 1, PIN#	Break out board connection
Spindle ON/OFF	6 & 10	AUX I/O 1, MOLEX PIN 1 & 2
Spindle Speed (0 – 10 VDC)	12 & 13	AUX I/O 1, MOLEX PIN 3 & 4
10 VDC Reference voltage	14	AUX I/O 1, MOLEX PIN 5
Spindle stop	7 & 11	-SS+

Encoder signals, DB15

Signal	D-Sub Pin#	Renco	Q-Phase	MCG
- Index	2	Yellow	Yellow	Yellow
- Ch A	3	Brown	Brown	White
- Ch B	5	Blue	Blue	Green
Sheild	8	Bare	Bare	Bare
GND	9	Black	Black	Black
+ Index	10	Orange	Orange	Orange
+ Ch A	11	White	White	Brown
+ Vcc	12	Red	Red	Red
+ Ch B	13	Green	Green	Blue

Motor power connector

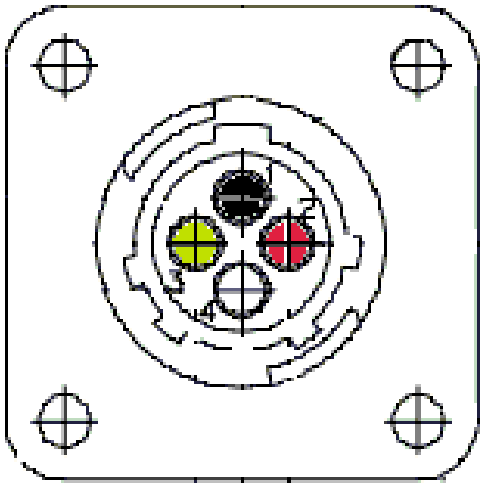

Figure 29: Motor power connector

Pin#	Description
1	Black (Power GND) / ARM2
2	Red (Power, 48V PWM) / ARM1
3	Magnetic brake (GND)
4	Magnetic brake (24 VDC)

Note: Pin #3 and #4 are only wired for Z-axis.

AUX I/O 2

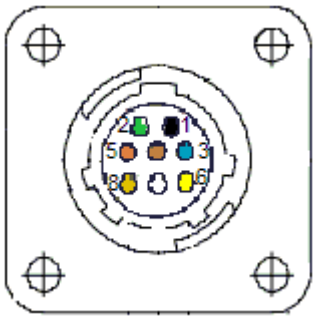

Figure 30: AUX I/O 2 used with automatic tool changers (ATC).

Pin#	Description
1	Manual Release
2	GND
3	12 VDC
4	Tool Release Sensor
5	GND
6	12 VDC
7	Tool Clamp Sensor
8	GND

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Case Connectors

Figure 31: This is a photo of a fully populated connector plate. Some of these connectors may not be available on your system.

SERVO POWER: This is the power for energizing the amplifiers and boards inside the controller case. The power rating of the cable is dependent on the customer machine type and requirements, see the nameplate. In the picture above the power needed is 15A at 115 Volt AC (VAC). The system is delivered with appropriate power plug. International customer may receive the system without power plug.

MOTORS, X, Y, Z, X2/A: The four pin black connectors deliver power to CNC motors. X2/A may not be avialable on all controllers. Z-axis motor connector is providing 24VDC for disengaging the magnetic brake on the Z-axis.

RELAY CONTROLLED AUX POWER: These two power receptacles work together. The rating is limited to 10A at 250 Volt AC (VAC). You need an additional power input to the receptacle on the right. The relay switchs the power ON and OFF with spindle ON and OFF command. This arrangement has been used to control

- Small handheld routers such as Kress, Porter cable, etc or
- Vacuum dust collector or
- Spindle fan on larger spindles such as the ones installed on Automatic Tool change systems (ATC)

LIMIT SWITCH: This connector will bring signals from limit switches back to the controller. Othe signals that use this connector are:

- Gantry ESTOP signal
- Power and signal to probe (Z-touch plate)

- Power to mister solenoid
- Power to tool release solenoid on Automatic Tool change systems (ATC)

AUX I/O 1: This connector is used to control spindles connected to a Variable Frequency Drive (VFD) also known as inveter. The spindle ON/OFF signal is controlled by an on-board relay inside the controller. The 0 to 10 Volt DC (VDC) reference signal is generated out of the 24 VDC power from VFD. At 10 VDC the spindle should run at its maximum RPM. This connector makes the controller electrically isolated from VFD. For proper operation, VFD should be grounded to the building ground which is the same ground coming to the controller case thru power plug. If the machine is not connected to a proper grounding, there is a high risk for electrical shocks. You will also experience problems with spindle speed control. Signals supported by this connector are:

- Spindle ON/OFF
- Spindle stop signal used with Automatic Tool change systems (ATC)
- Spindle speed control 0-10VDC

AUX I/O 2: This connector is used with Automatic Tool change systems (ATC). Signals supported by this connector are:

- Tool Release (T/R)
- Tool Clamp (T/C)
- Manual tool release, by pressing the green button on ATC, the tool should be released.

AUX I/O 3: This connector is used with systems with additional control board such as smooth stepper systems. It provides USB or Ethernet connection to the control board.

Encoders, X, Y, Z, X2/A: These connectors are used to bring encoder feedback to amplifiers (drives). X2/A may not be available on all systems.

Parallel Port: Male or Female DB25 parallel port connection to controller's computer. It is not connected if the system is controlled by additional control board such as smooth stepper.

Serial Port: Male or Female DB9 serial port connection to controller's computer. This connector is used for MODBUS communication. It is not available on all systems.

Front Panel LED:s, ESTOP, ... etc

Figure 32: LED:s are showing the status of the machine.

FAULT: If this LED is ON, it indicates an amplifier (drive) fault. This can be due to either no encoder feedback or a collision. After a fault due to collision, the machine position is not correct any more and it should be homed again. To clear a FAULT error, push the ESTOP button and wait till HV light is OFF. This will reset the drives. Then by pulling the ESTOP you will get back the HV light while the FAULT is OFF. You can home the machine now. If you still have FAULT light ON, then there is an encoder feedback problem.

ESTOP: When all ESTOP pushbuttons are pulled out, this LED is ON.

HV: This LED is ON, when the 48 Volt DC is available to power the drives. If after enabling the system thru software, there is no HV light, check the front panel fuse.

LIM X, LIM Y, LIM Z, LIM X2/A: These LED:s show the status of limit or home switch. If the machine is away from its home position on that particular axis the LED should be ON. If you use a screw driver and push the lever on the side of the limit switch you should see the status of LED change on the related axis.

Tool Release (T/R): This LED should be ON when the tool is released. The signal is coming from Automatic Tool Changer spindle.

Tool Clamp (T/C): This LED should be ON when the tool is clamped. The signal is coming from Automatic Tool Changer spindle.

Spindle Stop (S/S): This LED should be ON when the spindle is stopped. The signal is coming from VFD and used with Automatic Tool Change systems (ATC).

Mister: This LED should be ON when you enable the mister from software. When the LED is ON, you should have 12 VDC provided to the solenoid valve.

Spindle: This LED should be ON when you enable the spindle from software. This can be either a small spindle router connected thru "RELAY CONTROLLED AUX POWER" or spindle control thru "AUX I/O 1". With Automatic Tool Changer systems (ATC), you should see spindle fan running when the spindle is turned ON. The spindle fan is controlled thru "RELAY CONTROLLED AUX POWER". If you are controlling a dust collector thru "RELAY CONTROLLED AUX POWER", you should see it turn ON at the same time as spindle.

Brake: This LED should be ON when all the ESTOP:s are pulled out and System is enabled from software. It indicates that the 24 VDC has been supplied to magnetic brake of Z-motor. If the system has a magnetic brake and this LED does not turn ON it means that brake is still engaged. The machine should be stopped and problem fixed.

Z0: This LED should be ON when the probe (Z-touch plate) is touching the tip of router bit in spindle. The spindle and VFD should have proper grounding, otherwise the probe will not function. With Automatic Tool Change system a jumper wire with a small magnet at the end of it should be put on spindle collet to close the ground connection as the ATC spindle collet is electrically isolated from spindle body.

Figure 33: Photo from the front and left side of controller case.

ESTOP: The machine will be stopped by pushing the ESTOP pushbutton. There might be additional ESTOP:s on the side of gantry.

FUSE: The front panel fuse should be rated for the correct voltage and amperage. **Disconnect the power plug to the controller when you replace or test the fuse!**

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ON/OFF: After turning the controller ON, you should see the light in the switch to turn ON. If this light is not ON check the power coming to the controller. The receptacle that powers the controller and also the fuse (or circuit breaker) should be rated for the correct voltage and amperage of the controller.

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Crate Dimension and Weight

The dimension of finished connector is 19" x 24" x 5 1/2".

Add 1/2" on each side for bubble wrap. The inside dimension of wood crate should be: 20" x 25" x 6 1/2".

The weight is 50 Lbs for a standard 3 axis controller and 52 Lbs for a 4 axis controller.

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Parts

Description	Part number
Breakout board	RCS4AXIS v1.7
Slow Blow fuse for 110VAC controller	MDA-15
Slow Blow fuse for 220VAC controller	MDA-7
48V DC control Relay	Crydom D2425
AUX Relay for control of dust collector, small spindle or spindle fan	T92S11D22-12
DC Servo Drive	DG3S-08020
Power Supply 5VDC	S-25-5
Power Supply 12VDC	S-60-12
Power Supply, Dual output 5VDC and 12VDC	D-60A